



Fig. 1—C. K. SOBER.

COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN No. 123.

Chestnut Culture

IN

PENNSYLVANIA.

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TABLE OF CONTENTS.

	Page.
List of Illustrations,	5
Preface by Secretary Critchfield,	7
Letter of Transmittal,	9
Successful Reclaiming of Forest Lands,	10
The Sober Method of Propagating the Paragon Chestnut,	13
The Paragon Chestnut, History of,	14
The Sober Chestnut Groves,	15
Methods of Chestnut Culture,	18
Chestnut Groves, How to Start,	18
Grafting Chestnut Trees,	20
Chestnut Orchards, How Established,	22
Chestnut Culture, Experiments with,	23
Grafting and Budding Chestnut Trees,	25
Grafting, Mistakes in,	27
Grafting Outfit, Description of,	28
Grafting Wax, Formula for,	28
Harvesting Paragon Chestnuts,	29
Chestnuts, How to Preserve when Gathered,	30
Economic Value of the Chestnut,	30
Chestnuts as a Source of Flour,	30
Chemical Composition of the Chestnut,	31
Chestnut Culture More Profitable than Wheat,	31
Chestnuts as an Important Dietary,	32
Composition of Nuts and Certain Food Materials,	33
Food Products, Composition of Various,	34
Composition of Chestnuts and Other Foods,	36
Nutriments in Various Articles of Food,	36
The Paragon Chestnut; its Food Value, etc.,	38
Chestnut trees, How Propagated,	39
Chestnut trees, How and When to be Grafted,	39
Description of the Plates or Figures,	42
Cleft Grafting of Chestnut Trees,	44
The Splice or Whip Graft,	45
Poultry in Chestnut Groves, Benefit of,	47
Transplanting Chestnut and Other Trees,	48



LIST OF ILLUSTRATIONS.

	Figure.
C. K. Sober, Portrait of (<i>Frontispiece</i>),	1
Chestnut Grove Stock Farm,	2
The Chestnut Grove; Three years old,	3
Paragon Chestnuts; Natural size,	4
Paragon Chesnut Bur with Nuts; Natural size,	5
Paragon Chestnuts; Natural size,	6
Nuts, 1-5 are covering 50 cent pieces; nut No. 6 is covering a silver dollar. Seven nuts measure 10 inches,	7
Harvesting in 1902,	8
Chestnut burs spread on the ground to dry,	9
Native chestnut forest. Long Island, N. Y.,	10
Third growth native chestnut trees around old stumps. Long Island, N. Y., 1903,	11
Sprouts before and after grafting,	12
Grafts inserted June 10, 1902. Photograph taken October, 1902,	13
Graft one year old. The tops show where to cut it back,	14
The "wedge" or "cleft" graft,	15
Wedge graft; four years old,	16
Budding,	17
Budding; three years old,	18
The "tongue" or "whip" graft,	19
The "whip" or "tongue" graft,	20
Tongue graft; three years old,	21
Grafting outfit; scions; machine for winding waxed muslin on corn cobs, Buds left on the stocks below the grafts will get all the nourishment, and the grafts will die,	22 23
Perfect union, whip graft,	24
Defective whip graft,	25
Cleaning the grove. Asbestos covered screens protect the trees from the fires,	26
The grove in winter. No danger from forest fires,	27
The trees in the grove are too thick. Improvement cuttings are being made continually	28
An ideal tree,	29
A normal yield,	30
Three hundred young burs were picked from this tree; two hundred were left to mature,	31
The grafting of large trees did not prove a success,	32
Chickens devour many insects,	33
Paragon nuts sprouted ready for planting. Mr. Sober cuts the sprouts off before planting the nuts,	34
Seedlings from Paragon nuts. See description of figure,	35

Seedlings from Paragon nuts. See description of figure,	36
Seedlings from Paragon nuts. Photograph taken during the first summer,	37
At the left, nuts destroyed by "bur" worms; on the right, destroyed by larvae of weevils,	38
Pupae of chestnut weevil, June, 1903,	39
Chestnut Weevil (<i>Balaninus Caryatrypes</i>); the female has the longer beak,	40
Chestnut weevil, natural size, August, 1902,	41
Snout of weevil penetrating bur. Below, the nut and seed-coat are shown, also pierced by snout,	42
Bur-worm at work,	43
Nuts attacked by bur-worm will afterwards mould,	44
Defective graft blown over by wind,	45
Chestnut trees girdled by meadow mice,	46

PREFACE.

DEPARTMENT OF AGRICULTURE,

HARRISBURG, PA., *October 1, 1904.*

Several months ago it was my privilege to visit the farm of Mr. C. K. Sober, in Northumberland county, Pennsylvania, where I saw what I regarded as a possibility of turning much of the unproductive land, especially in the mountainous sections of this State, to permanent usefulness.

Within the last quarter of a century the timber has been removed from many hundreds of acres of land that possesses little value for raising ordinary farm crops. Much of this land was originally covered with a heavy growth of chestnut timber. The chestnut tree is one of the most rapid growers found among the native timbers of our State, and in a comparatively short time after a chestnut forest has been cut down, a luxuriant second-growth appears.

The importance of the nut-growing industry in the United States is attracting considerable attention, and whatever may be said concerning the utility of cultivating nut-bearing trees upon lands adapted to the production of other valuable crops, there can be no doubt that very much can be added to the income of owners of lands covered with the new growth of chestnut trees referred to, by grafting upon these trees the improved varieties of chestnuts for which there is a great demand in our markets.

Believing in the possibility of thus turning large areas of land within this Commonwealth that are now entirely unproductive to usefulness and consequent largely increased value, the following Bulletin was prepared, and it is sent out in the hope that it may be the means of encouraging and assisting many of our land owners to increase their income without the necessity of a large outlay at the beginning.



Secretary of Agriculture.



LETTER OF TRANSMITTAL.

LEWISBURG, PENNA., *Sept. 20, 1904.*

HON. N. B. CRITCHFIELD, *Secretary of Agriculture,*
Harrisburg, Penna.

DEAR SIR: In accordance with your request, I have the honor to submit herewith photographs and manuscripts for a Bulletin on "The Propagation of the Paragon Chestnut," especially as carried on by Mr. C. K. Sober, of Lewisburg, Pennsylvania. During the past few years Mr. Sober has received hundreds of letters of inquiry concerning his chestnut groves, and his method for the reforestation of the denuded woodlands of our State. As only a very few people are familiar with his extensive and remarkably successful work, a bulletin on the subject may prove both interesting and valuable. His experiments have been carried far enough to show that the growing of chestnuts for the market is a paying business venture.

In Europe the cultivated chestnut is an important food product, and in Italy, France, Spain and Turkey, it serves as one of the Chief articles of food to the peasants, who long ago learned how to prepare it. In recent years much interest has been manifested relative to the commercial value of chestnuts, and there has been a steady increase in the demand for large nuts. These find a ready sale, and this fact has encouraged the cultivation of various European and Japanese varieties by horticulturists.

In America the chestnut is not known as an article of food, and the only time we see it is during a few weeks in October and November, when it is considered a luxury. A few connoisseurs know that it has many uses aside from filling the turkey at Thanksgiving. The chestnut may be used as a vegetable, or ground into a flour and made into bread, or prepared as a soup or pudding. Chestnuts made into candy are also well known.

When a boy, Mr. Sober conceived the idea of improving our native chestnut by cultivation and artificial propagation, but this idea was not realized until a few years ago when he bought the old homestead which is now well known as the "Chestnut Grove Stock Farm." Soon after the purchase of the farm, preparations were made to carry out his long-cherished idea of cultivating chestnuts. Mr.

Sober recognized that the greatest value of our native chestnut (*Castanea dentata*), lies in its roots, the sprouts from which furnish the best possible stocks upon which to graft the cultivated chestnut. He had early been advised "to make no mistake in the selection of a nut, but to get the Paragon."

With his characteristic energy Mr. Sober began experiments with the Paragon chestnut in 1896, and to-day there is not a more promising chestnut grove in America than the one to be seen on the Chestnut Grove Stock Farm. It was soon learned that the Paragon does exceptionally well on the stocks of the American chestnut, and as Mr. Sober's farm contained some three or four hundred acres of waste mountain land from which the valuable timber had been cut, he at once began to reclaim it. The ground was cleared and the young shoots from the chestnut stumps were allowed to grow until one or two years old, when they were grafted. In this manner about three hundred acres have already been reclaimed.

The object of this Bulletin is to give to the farmers and fruit growers of our State the benefit of the knowledge which Mr. Sober has gained during his eight years' experience in cultivating the Paragon chestnut. No attempt will be made to give the history of the introduction of the cultivated chestnut into America, or to discuss the merits of the several varieties, such as the Numbo, Ridgely, Alpha, Reliance, Hall, or Parry. The Paragon is recommended above all others for Pennsylvania having produced the best results.

The photographs published in this bulletin were taken during the years 1902 and 1903, and I wish to express thanks to Mr. Sober for his kindness and patience in explaining fully the various processes of cultivation. Without his co-operation I could not have obtained many of the most valuable photographs.

Prejudice and ignorance are among the factors which keep many from attempting the cultivation of the nut. The American people will soon learn the value of chestnuts, and then the demand for them will increase. Chestnut culture in the United States is in its infancy, but the demand for the larger nuts has stimulated their production, and during the past few years much has been written on the subject, and especially upon its value in the reclaiming of waste forest lands. The Seventh Annual Report of the Forest, Fish and Game Commission, State of New York, 1903, contains an excellent article by E. A. Sterling, on Chestnut Culture in Northeastern United States. A monograph on Nut Culture in the United States, published by the Division of Pomology, in 1896, includes a full treatment of the subject of chestnut culture. The Nut Culturist, by A. S. Fuller, 1896, contains an article on the propagation, planting and cultivation of the chestnut. Farmers' Bulletin No. 114, pub-

lished by the U. S. Department of Agriculture, includes a short but excellent summary of recent experiments in chestnut culture. A bulletin issued from the Delaware Experiment Station details "the history, uses, culture, botany, enemies, value and present status of European and Japanese varieties in the Eastern United States." The Connecticut State Station contains the results of experiments in chestnut grafting. Farmers' Bulletin No. 122, U. S. Department of Agriculture, tells about the value of nuts as food, and Farmers' Bulletin No. 142, U. S. Department of Agriculture, by W. O. Atwater, Ph. D., includes the chestnut in giving the Principles of Nutrition and Nutritive Value of Food.

From these and other sources valuable suggestions have been taken.

Yours very truly,

NELSON F. DAVIS,

Professor of Biology and Zoology, Bucknell University.



Chestnut Culture

IN

PENNSYLVANIA.

The Sober Method of Propagating the Paragon Chestnut.

By PROF. NELSON F. DAVIS,

Zoologist and Biologist, Bucknell University, Lewisburg, Penna.

Mr. C. K. Sober is a prosperous citizen of Lewisburg, Union county, Pennsylvania, a member of the State Game Commission, a prominent lumberman, being a member of the Glen Union Lumber Company, a most zealous sportsman and well-informed naturalist, and, because of his tireless energy and persistence, a successful business man. He was born November 24, 1842, at the old homestead of his father in Northumberland county, Pennsylvania, about seven miles from Shamokin. Until eighteen years of age he remained at home, working on the farm during the summer months and attending the neighboring schools during the winter.

From his father Mr. Sober received his first lessons in grafting, and one day while helping to graft apple trees, he suggested to his father that they graft some chestnut trees. One fine old tree nearby bore chestnuts of unusual size and excellent quality, and from this tree the boy wished to graft scions upon other native trees. The idea was new, and the father laughed and asked, "Who ever heard of grafting chestnuts?" This dream of his boyhood days was not forgotten, and years afterwards, in 1896, when Mr. Sober purchased the "old homestead," now known as "The Chestnut Grove Stock Farm," he grafted some scions from this old chestnut tree, and the dream thus became a reality.

Although a man with various interests, Mr. Sober derives most pleasure from his farm. After purchasing the homestead, he began, with his characteristic energy, to improve the property, and to-day it is a beautiful country estate, a model farm.

The Chestnut Grove Stock Farm is situated in the beautiful Irish Valley, about seven miles from Shamokin, on the Pennsylvania

and the Philadelphia and Reading Railroads. The Allegheny range in this region of Central Pennsylvania consists of low parallel ridges, covered with second growth timber. A few years ago the hillsides of these ranges were covered with pine, oak and chestnut, but the valuable timber has been removed, and the hillsides are now considered as waste mountain lands.

Mr. Sober's estate contained some four hundred acres of this so-called waste mountain land, and the experiments with cultivated chestnuts were begun in order to see whether or not this land could be reclaimed. Mistakes were made at first, but in spite of them, Mr. Sober saw success ahead, and one by one the mistakes were corrected until to-day three hundred acres have been reclaimed.

THE PARAGON CHESTNUT.

According to the late Henry M. Engle, of Marietta, Pennsylvania, who was an enthusiastic advocate of chestnut culture, from whom Mr. Sober first obtained his scions for grafting, the original Paragon tree was grown by the late W. L. Shaffer, of Germantown, Pennsylvania, from a nut supposed to have been brought to this country from Europe; perhaps from France or Spain. Mr. Engle at once recognized the value of the nut and commenced to cultivate it extensively. Thus it was introduced to the public. The nuts are of excellent quality and compare favorably in sweetness and delicacy of flavor with the native chestnut. In fact, in tests made, after drying the nuts slowly for about two weeks, just enough to shrivel them slightly, and then removing the seed-coat, which is somewhat bitter, they could not be distinguished from the native nut. In the tests the nuts were cut into small pieces. The mistaken opinion prevails, however, that they, like the Japanese nuts, are bitter and astringent.

The nuts are from three to four inches in circumference, and occasionally one is found that will cover a silver dollar, while an average nut will cover a silver half dollar. Thirty-two selected nuts, when first gathered, weighed a pound, and forty-eight average nuts filled a quart measure. The nut is a little darker in color than the native chestnut, although both vary considerably, and is covered with a delicate pubescence when first gathered. It ripens the last week in September or the first week in October. The burs are large and thick, only slightly flattened, the spines being long and stiff, and the nuts averaging from three to five in each bur.

Mr. Andrew Fuller says of the Paragon chestnut, in the *Nut Culturist*, 1896: "Burs of immense size, often five inches and more in lateral diameter; distinctly flattened on the top, or cushion shape, spines an inch in length, widely and irregularly branching from a stout-stem, springing from a thick, fleshy husk, the whole making

an involucre or bur out of proportion to the nuts within; nuts of large size, slightly depressed at the top, and they are usually broader than long; shell very dark brown, slightly ridged, and covered with a fine but not very conspicuous pubescence, kernel sweet, fine grained and of superior flavor for one of this species. Tree hardy, exceedingly precocious and productive when grafted on strong, healthy stock, a four year old tree being loaded. This is one of the best of its class; origin somewhat in doubt, but it is claimed that the late W. L. Shaffer, of Philadelphia, raised it from a foreign nut, planted in his garden, and who some eighteen years or more ago, gave scions to H. M. Engle, of Marietta, Pennsylvania. Mr. Engle has since propagated and disseminated this variety quite extensively under its present name, but should further investigation prove it to be distinct, and that it was raised by Mr. Shaffer, then it should certainly bear his name, and "Paragon" become a synonym. No more appropriate monument could possibly be erected in honor of a distinguished horticulturist like the late Mr. Shaffer, than a chestnut tree, nor could his memory be perpetuated under more pleasant and agreeable surrounding than to have his name linked inseparably with such an excellent and valuable variety."

(New York). E. A. Sterling, in the Seventh Report of the Forest, Fish and Game Commission, 1903, says: "Undoubtedly the best variety for general planting produced up to date is the Paragon. The tree is hardy within the range of the native chestnut, ripening moderately early; in Central Pennsylvania, about October 1st, and comes into bearing very young, and is exceedingly prolific. In fact, the young trees are such heavy bearers that it is almost a drawback to their value. They will exhaust their vitality and die, or lose their vigor of growth, if unrestrained. Paragon grafts take exceedingly well on American stocks, and have been known to grow well when grafted upon red oak sprouts; while not free from insect attacks, the Paragon is much less affected by the weevil than are other varieties.

"A not serious reduction of its many good qualities is the tendency of the burs to remain closed and fall to the ground with the nuts still retained. They open readily, however, if spread in the sun; hence the only detriment is a slightly additional cost of harvesting. It saves, on the other hand, however, the loss and difficulty occasioned by picking the nuts from the grass and debris beneath the trees. For planting in this State (New York), the Paragon can be safely recommended above all others."

THE SOBER GROVES.

Mr. Sober had nearly four hundred acres of waste mountain land on his estate, and to reclaim this was his desire. Originally it had

been covered by a dense growth of pine, but this had been cut off years before, and in its place oak and chestnut came up, with other hard wood trees. This had again been cut down and all valuable timber sold, only stumps, brush and worthless logs remaining.

During the winter of 1896 the rubbish was removed from one hundred acres of this land, and the following spring and summer a vigorous growth of sprouts sprang up around each stump, many sprouts being from six to eight feet high, and over an inch in diameter at the base. (Fig. 10.)

In the spring of 1898, two years after the clearing of the land, the grafting began. Professional grafters were employed, but the results were very discouraging, as less than five per cent. of the scions lived. The wedge graft was used, but the union was so imperfectly made that although a fair number started, most of them died, or were blown off by the wind during the summer. The rapid growth of the scion, made possible by the established root system of the stock, was too much for the young shoots (the weight of the leaves making them top heavy), and so many were blown off by comparatively light winds.

In 1899 Mr. Sober began to experiment on grafting and devised methods to reduce the failures in the various processes, and gradually, one after another, the difficulties were overcome. In 1900, Mr. Sober personally looked after each grafter and instructed him in every step. As a result 75 per cent. of the scions grafted in that year lived. The "whip" or "tongue" graft proved to be the most successful.

The trees first grafted were now in a condition to furnish an abundance of scions, and each year, during February and March, bundles of scions were cut and kept in a cool place, packed in damp sand or moss. The scions must be kept dormant, and usually about May first, they are placed in boxes and buried among the cakes of ice in an ice house, where they remain until wanted. May is the month for grafting, although the season varies somewhat from one year to another. During the first few years of his experiments Mr. Sober tried the various methods of grafting. Wedge (cleft) grafting proved good, if properly applied, but it is not recommended for chestnuts.

A wedge graft may be inserted if the stock is larger than the scion to be grafted upon it. It takes more time to complete a wedge graft than a whip graft, and it is more apt to be blown off before reaching the second year. Figure 15 shows a perfect union from a wedge graft.

Budding was used for a time but has been abandoned. In budding, an "eye" (bud) is inserted under the bark of the stock. The "eye" is left attached to a piece of bark, which, in the spring after

the sap has started, is easily separated from the wood. Mr. Sober prefers to use "buds with a woody shield," i. e., instead of separating the bark with a bud upon it from the wood beneath, the bud is cut off, together with a small piece of wood beneath the bark. This method of "budding" is really "grafting." (Fig. 17.)

The method now used almost exclusively and the only one recommended for chestnuts by Mr. Sober, is splice (tongue or whip) grafting, (Fig. 20). In this method a union is made with a young shoot containing one or two buds, usually only one, and an approximately equally developed wild stock. The scion and stock should be of nearly the same diameter, but a perfect union may result when the stock is larger than the scion. It is difficult to get good grafters, so Mr. Sober has given up entirely employing so-called professional grafters, and gets far better results by using "green" men and teaching them his own methods. This can be done in a very short time. He has found that carpenters and men with some mechanical ability make the best grafters, because they make more perfect unions.

Fig. 12 shows some young chestnut sprouts, one year old, ready to be grafted. Not all the sprouts are of the same diameter, and some are more favorably situated than the others. As a rule, the sprout which arises from the lowest part of the stump, under ground, if one is so situated, will be the one to graft. It will become an independent tree sooner than the others. Two or three sprouts should be grafted around each stump. First remove with a sharp knife, or pruning shears, all branches and buds from the stock, then cut off the top, leaving three or four feet upon which to graft the scion. The buds below the graft must be watched and broken off as fast as they develop, otherwise they will get all the nourishment and the graft will die (Fig. 23). The buds below the graft must be rubbed off at least three times in one season. After the grafts are started, they must be protected; some may be killed by a late frost immediately after starting; others may be broken by the wind, and some may be destroyed by long droughts or other causes.

It seems best to clean the ground around the young grafted trees during the second season. This is done by grubbing, mowing and burning. If the chestnut grove is on a mountain side, or where there is a danger from forest fires, every precaution should be taken to keep the fire out. Mr. Sober accomplishes this by means of fire lanes around the entire orchard. The undergrowth grows very rapidly. During the past four years Mr. Sober has employed from fifteen to twenty Italians in his groves; some cleaning new ground preliminary to grafting; others keeping the young groves clean.

New problems present themselves constantly. Three hundred acres have been grafted, and the stand is excellent, varying some-

what, but there are certainly many more trees on the ground than can be left after five years. The best trees will be left standing and the others used to furnish scions, so that the grove will be thus kept trimmed back, until finally only perfect trees will be left standing. Last year the groves were mowed twice during the season, as a protection against fire. This makes the caring of the groves expensive. This year the trees on nearly three hundred acres are large enough to admit sheep, (small trees, of course, would be injured by them). Mr. Sober is now building a fence around the groves. Over seven miles of wire fence has already been placed through the groves. It is proposed to pasture the sheep in the groves during the day, and at night take them to a movable sheepfold, where they will be kept during the night. This movable sheep fold will consist of poles and the netting may be wound on them, and thus readily moved from place to place. By this means much solid and liquid manure will be distributed over his farm land. It is expected that the sheep will keep the groves fire proof. As the trees become larger, cattle will be pastured with the sheep. Five hundred sheep are now in the orchard, (July, 1904). Many of the trees are now five and six years old, and are bearing exceptionally well. As before stated, every day presents some new problem. What is the best way to harvest the crop? What shall be done with the nuts? How shall they be protected from enemies? What are the enemies? These points are of such vital importance to the chestnut grower that they must be treated separately and in detail.

METHODS OF CULTURE.

Chestnuts may be raised in "groves" or "orchards." The term "grove" is applied to the growth which results from the grafting of foreign or improved native varieties upon native trees, especially upon young stump sprouts. When seedling chestnut trees are grafted in the nursery, and afterward set out in rows, usually in cultivated land, the resulting growth is called an orchard. In a grove the trees are without regular arrangement, while in the orchard they are usually set about twenty-five or thirty feet apart. Sometimes chestnuts are planted in hills, twenty-five or thirty feet apart, and the young seedlings allowed to remain for two or three years, and then grafted. This, of course, produces an orchard, and a decided advantage is the fact that the young trees do not need to be transplanted. While the seedlings are growing, other crops may be raised between the rows.

GROVES.

The chestnut grove may be started wherever there is a good stand of chestnut timber. Seldom will the growth be pure, but if one tree in three is a chestnut, no more are necessary.

The distribution of the native chestnut over so wide a territory and on so many kinds of soil, makes it possible to have groves in many localities. Thousands of acres in Pennsylvania are simply waiting to be reclaimed. Seventy-five to one hundred trees per acre will make a good start for a grove. Seedlings may be planted in the spaces between the native trees, and all along the Allegheny mountains, from Canada to Alabama, and in practically every State east of the Mississippi, the native chestnut is sufficiently abundant to make the chestnut grove a possibility. The chestnut occurs in all kinds of soil, from pure gravel on Long Island (Fig. 11), to red shale in Central Pennsylvania. I have seen only a few trees in limestone soil, and these bore but very few nuts. Dry, stony, mountain sides seem preferable to the richer alluvial soil of the valleys. The soil must be well drained and not composed of clay. Chestnuts will withstand exceptionally dry weather without injury to the maturing fruit.

Climate is another very important feature, and must be taken into consideration with each variety. Fuller, in the "Nut Culturist," says: "The range of climate in which the native sweet-chestnut thrives is quite extensive, as it is found sparingly in Maine, in latitude 44 degrees, extending westward—but not very abundant on this line—through New England and New York, crossing the Niagara river, skirting the north shore of Lake Erie in Canada and thence into Southern Michigan, but does not reach Illinois. From this line southward it increases in abundance in Virginia, Western North Carolina and Eastern Tennessee and Kentucky. But in following this tree southward, we meet another indigenous species, widely known as Chinquapin (*Castanea pumila*). This species is indigenous to Southern New Jersey, and sparingly in parts of Pennsylvania, becoming more plentiful as we proceed southward, the two species named, overlapping and in part occupying the same region; but the Chinquapin extends further south, and also to the westward, near its northern limits crossing the Mississippi into Southern Missouri, then extends south again, becoming quite abundant in Arkansas.

"The European chestnut, in its many varieties, extends over about the same number of degrees of latitude in Europe as our species do here, although reaching a higher latitude in countries bordering on the Atlantic, as shown in the old chestnut trees of England. The Oriental chestnut has also a very wide range, but the limits are not so well known as those of the American and European species, but a study of its geographical distribution is of considerable importance, now that we are importing these nuts for cultivation. The same is also true of the European varieties, and the cultivator who

neglects to take this matter into consideration will fail to secure whatever advantages may have accrued from acclimation, an agency which, undoubtedly, has been active and continuous in modifying and changing the primary characteristics of these plants during un known ages."

In this country wherever the native chestnut flourishes and fruits, it seems that the Paragon, when grafted on the native sprouts, will also do well. To start a grove, then, all that is necessary, if the Paragon is used, is to have a mixed growth of chestnut with other hard woods. Many oak trees have been successfully grafted with the chestnut, especially red oak, scarlet oak, and chestnut oak; white oak grows too slowly, the scion soon becoming larger in diameter than the sprout. The extent to which cultivated chestnuts can be successfully grafted upon other hard wood trees has not been determined.

Grafting is successful only between nearly related plants; for example, the apple with the quince, or the peach, plum, almond and apricot with each other. Not the apple with the peach or the plum with the quince. Theoretically, therefore, the chestnut should be grafted successfully on the oak or beech.

Having selected the area for the grove, work may begin at once, but preferably during the fall and winter months. All trees in the proposed grove should be cut down and the brush burned, leaving the ground as clean as possible. Frequently the lumber removed will more than pay for the clearing. If the selected ground is already waste land, it may be ready for grafting the following spring, or it may be necessary to clean the ground, removing the brush and rubbish by burning. If there is a chance to select the location of the grove, it should be located where it may easily be protected from forest fires. It is desirable to make fire lanes at once, before beginning the grafting. Fire is the worst enemy of the chestnut grove, but by keeping the ground clean, it may be controlled.

Having cleared the ground during the winter, it is necessary to wait one year for the chestnut sprouts to grow before they are ready for grafting. During this time the fire lanes may be made. The following spring, which is the second after clearing the ground, the grafting should begin. The sprouts which come from the lowest portion of the stump will become independent trees before those which arise higher up, and, therefore, should be selected. Fig. 11 shows that the sprouts coming from the lower portion of the stump will make the fastest growth. At least two such sprouts, or more, according to circumstances, should be grafted on every stump, and on opposite sides if possible. Both may remain for several years, and if one is found to be superior to the other, the poorer one may

be used to furnish scions. The sprouts which were not grafted should be allowed to remain for a few seasons to protect the young grafts from the wind and frost. When the grafts are one year old they should be cut back in order to get a good top. The growth during the first year is usually fan-shaped and will not make the best shaped tree. On the original scion only one or two buds are left, and these grow with surprising rapidity during the first year. When only one bud has been left on a graft, it will sometimes make the enormous growth of nine feet without a single branch. This growth is made possible by the established roots of the old stump. In cutting back such a sprout, from three to five buds should be left. This will insure a low crown, which is as desirable in chestnuts as in peaches. In cutting back the young grafts, another supply of scions is furnished. In exposed portions of the grove, the young sprouts are protected from the wind by allowing the undergrowth to remain when clearing the land for the grove. After two or three years, the grafts are firmly established, and then everything is cleared away. By keeping the orchard clean, the harvesting is facilitated, and there is less danger from fire, and insect pests can be fought with greater ease.

Fig. 26 shows the method of protecting young trees from heat during the burning of brush. The trees are five years old and the screens are covered with asbestos. The orchard was cleaned twice during 1903, and in 1904 will be kept clean by means of sheep, which, in the fall, will be sold. As the trees become larger, cows will be added; thus the orchard will be kept clean without the aid of Italians.

If grass is allowed to remain around the younger trees during the winter, serious results may follow from the destruction of the bark near the base of the tree by mice—meadow mice will girdle the trees. Fig. 46 shows a tree completely girdled by mice.

The trees begin to bear when two or three years old, but should not be allowed to overbear. Fig. 31 shows a tree only four years old from which 300 burs were removed during July, 1902, and 200 burs were allowed to reach maturity. This was fully one hundred too many, as most of the burs contained only one nut, and this smaller than the average.

The sooner defective trees receive attention the better. If a graft dies during the first summer, the same stock may be grafted again the next year, but as a rule it is better to remove the defective tree entirely. The trees should not be allowed to become crowded, for the orchard will be improved by being thinned out, and improvement cuttings should be made whenever the opportunity occurs. By this method Mr. Sober has transformed, in five or six years

from the time the first work began, a natural chestnut forest into a Paragon chestnut grove that is giving returns, and the income will be large if no unforeseen elements enter. The Paragon nut is the general favorite. It is not expected that the crop will be full every year, but in temperate regions, at least one full crop is expected out of every two or three. Mr. Sober's grove has never, as yet, had an "off year."

In the chestnut grove every year brings something new. Obstacles are constantly arising. The insects are harder to control in a grove than in an orchard. For several years in Mr. Sober's grove we have been experimenting with methods for controlling pests, such as weevils, "bur" or "husk" worms, mice and other enemies, such as fire, thieves, etc. We trust that remedies will soon be found for them all.

ORCHARDS.

The chestnut orchard is possible in many localities where the native chestnut does not occur, and has some advantages, as well as many disadvantages, over the grove. It is easier to protect from enemies; it may be located near home, or just where you want it; no danger from fire need be feared; it is not as hard to keep clean; the land between the trees is available for other crops while the trees are maturing; a longer time is necessary to establish the orchard, as a root system must be developed. All things considered, it is not as profitable as a grove. However, Mr. Sober thinks that there is not an acre of farm land so valuable for other crops that in the end it would not pay to give it up to chestnuts.

The chestnut orchard must naturally start from seedlings (Fig. 35) which may be from the small native nut or from the larger improved varieties. The larger the nut, other things being equal, the more vigorous the seedling, as it has more food to feed upon. The natural method is to plant the seeds or nuts in the autumn as soon as they fall from the burs, but Mr. Sober has been more successful with the nuts kept over winter and planted in the spring. Some dry spot that has good drainage is chosen, and the nuts selected for planting are here buried in sand. In order to protect them from rodents they are kept in mouse-proof boxes. Slats are nailed over the bottom of the box, leaving room for water to run out, and the box so placed that it has perfect drainage, as the nuts must not become water soaked. A layer of sand is placed in the bottom of the box and then a layer of chestnuts, which are covered with sand, then another layer of chestnuts, and so on until the box is full. The cover of the box should also be mouse-proof, but open, so as to allow water to pass through. Finally, wire netting is nailed over the box, and a foot of sand makes a perfect covering.

During the past three years many experiments have been made with seedlings, and the following method is recommended. The nuts are not taken from their winter quarters until they have sprouted. When the sprout which is to become the tap root is about three inches long the nuts are carefully removed from the boxes, and are now ready to plant. Two methods of proceeding will give good results:

First. The nuts are planted in shallow drills, care being taken to lay the sprouts in a horizontal position, covering them about one and one-half inches deep with soil, the nuts having been planted about one foot apart in rows two or three feet apart. This will allow them to be cultivated with a horse. The tap root having been placed in a horizontal position will very soon send off numerous fibrous roots, and the seedling can be transplanted to the orchard at any time. (Fig. 36.)

Another method is to plant the nuts in shallow drills as before, but placing them in the ground, the sprout which is the tap root is cut off close to the nut, planted and covered as before. The tap root having been cut off, will now send out numerous fibrous roots (Fig. 35), and the seedling can be transplanted to the orchard without danger. This method is recommended by Mr. Sober.

A fair average growth for seedlings the first year is one foot. They may now be transplanted to the nursery rows, as soon as the leaves have fallen, or, better, transfer them to the orchard rows, where they are to remain permanently. In either case they will be ready to graft in about three years. In orchard rows they should be about thirty feet apart each way.

In two years seedling chestnuts are from two to three feet high. They should be grafted the third or fourth year, using the whip or tongue graft. As the budding of chestnut seedlings has not proven a success, in removing seedlings from one bed to another care should be exercised to protect them from the sun and wind in order that they may not dry out. Mr. Sober transfers them on a moist, cloudy day, if possible, or protects them with blankets or other covering. The young trees should be protected until they are firmly established. During the first ten years of the establishment of an orchard the ground may be used for other crops, but should be kept well fertilized, and especial care should be taken to avoid injuring the trees. By keeping the grass away from the seedlings they will be protected from mice which sometimes cause considerable trouble and expense by girdling the young trees (Fig. 46). Seedlings will begin to bear when about ten years old. Mr. Fuller says: "If the transplanted seedlings have produced any considerable number of side branches, and especially low down, these may be pruned off at

any time during the summer, for our object is to secure straight, upright stems for grafting the following spring, if they are large and tall enough; if not, we may delay this operation for another year. Of course, small chestnut stocks may be grafted close to the ground, but there is nothing really gained by this, for a good strong stock will push a scion forward more in one season than a weak stock in two or three seasons. But when the stocks have reached a diameter of from three-eighths to one-half an inch three or four feet from the ground, they may be grafted, but I would prefer to have them a little over than under these sizes."

He also calls attention to another point which is of value to one wishing to experiment with chestnuts, saying: "It is not necessary for a man who may need a few chestnut stocks for experimental or other purposes, to wait until they can be grown from the nut, because these can always be purchased from the nurseries; but if one does not wish to incur even this small outlay, it may be avoided by obtaining a supply from the forest, provided there are any in the neighborhood where chestnut seedlings are to be found, and the owner will permit their removal. The best wild stocks are usually to be found in recent clearings, or where the larger trees have been cut off for timber, and the underbrush, composed of seedlings and sprouts, is left to grow up again into a forest. There are many thousands of acres in New Jersey, New York and other Eastern States from which the timber is cut every twenty or thirty years, and no further attention paid to the land or what it produces. Wherever such clearings are found containing chestnut trees, good stocks can usually be procured by selecting those varying from one to two inches in diameter at the ground, and if the soil in which they are growing is rather poor and stony, they will usually have pretty good roots if carefully taken up. They should be pruned to a single stem, and this cut off at a height of from five to six feet or less, then planted where they are to remain permanently. Such stocks, if carefully taken up and planted, will throw out numerous sprouts from their stems during the summer, but all should be rubbed off while small and tender, except three or four at the top, and the following spring, if wanted for this purpose, they may be grafted in the same way as the young stocks growing in the nursery, thereby saving three or four years of time in securing bearing trees. Having often been employed in such wildings for stocks with just as good results as with those raised from nuts in nursery rows, I am inclined to recommend them where obtainable, knowing that there are thousands of farmers and owners of small places in the country who can do likewise, but may never have thought it practicable to transplant nut trees from the forest, although well aware

of the fact that elms, maples and similar kinds were obtained there, and in immense numbers, for planting in streets of villages and alongside country highways." I quote this because Mr. Sober had hundreds of trees removed from the forests and grafted with the Paragon scions, many of which are bearing to-day. Not only has Mr. Sober thus grafted chestnut seedlings, but he has also on his farm over one thousand cherry trees which he has grafted with the best varieties of cultivated cherries, and all from wild seedlings.

GRAFTING.

Grafting and budding are methods of propagation without the use of seeds. In grafting, branches called scions are cut from one tree and inserted into another in such a way that they grow together forming one plant (physiologically). A callus is formed between the cut surface of each, and in this callus the tissue forms connecting the like elements of each part.

In the cross-section of the stem or branch of a tree there is an outer skin called the epidermis; beneath this is the primary cortex and internal to this is the central cylinder. The primary cortex with its epidermis is, in popular language, called the bark. In grafting, it is important to see that the bark of the shoot (scion) is in contact with that of the stock, and that the layer next beneath is well joined together. (Fig. 24).

Plants can be grafted successfully only when they are nearly related. The varieties of one species can always be grafted on each other; and nearly related species usually do well. The various cultivated varieties of chestnuts can readily be grafted on each other or on the native tree. In grafting, however, it is well to select varieties having about the same rate of growth; chestnut, oak and beech may be grafted on each other, but the rate of growth among the various species is so different, that some of the combinations are unsuccessful, for example, chestnut and white oak.

Many methods of inserting cuttings are in use, but only the splice (tongue or whip) graft, the wedge (cleft) graft, and budding are used by Mr. Sober.

Splice (tongue or whip) grafting is recommended as the best method for chestnuts (Fig. 20), whether the grafts are to be inserted in young seedlings or young stump sprouts. The loss is less from this method than from the others. In recent years the stand obtained has been 80 per cent. to 90 per cent. With experienced grafters the success by this method is uniform. In the chestnut grove the details are as follows: The native tree is cut down during the winter, and the following spring and summer several sprouts will start around the old stump. These are allowed to grow until one

year old, when they are ready to graft. Especial care must be taken to select the best sprouts upon which to insert the graft. The largest and healthiest sprouts are not always to be chosen, as they may not come from the most desirable portion on the stump. Around any stump some sprouts will be more favorably situated than their fellows, and among these some will be lower down on the stump than others. Those coming from under the surface of the ground should, if possible, be selected, as they will establish their own root system and thus become independent trees very early, much earlier than those sprouts situated higher up on the stems. Two or three sprouts are grafted around each stump, and the other sprouts which have not been grafted are allowed to remain to protect the young grafts from injury during the first one or two years of their growth. Grafts not so protected are frequently blown off by the wind.

The advantages in grafting more than one sprout around each stump will more than pay for the extra cost. One graft will always be superior to the others, so that the best may be allowed to grow into a tree and the others cut back to furnish scions for the next year. Trees may be cut back for this purpose every year, and experience has shown that sprouts one year old are the best size for grafting; although, if for any reason the grafts on the one year old sprouts fail to grow, they may be replaced the following year, or the sprouts left standing for protection may be grafted the following year. At this time it may be well to use the wedge graft, although the whip or tongue graft can be used even though the scion is not so large as the sprout on which it is grafted. (Fig. 19).

Grafting may commence in the spring, as soon as the buds start, but it is better generally, to wait until the sap flows freely, although much depends on the season. May is the best month. Some years the sprouts are ready to be grafted as early as the middle of April, and again not until the first of May. Grafting may be continued until the middle of June, if the scions are properly preserved. Mr. Sober prefers to have the scion the same diameter as the sprout upon which it is to be grafted (Fig. 19), but does not hesitate to insert a smaller scion on a large sprout. In both instances the union can scarcely be detected after a few years growth. The scion, however, keeps its own peculiarities as to bark, leaves, fruit, etc.

Where there is a good stand of sprouts they should be grafted every ten to fifteen feet part; or from three to four hundred per acre. If there are open spots among the sprouts, seedlings are planted to fill up the space. This stand will be too thick for the ground after ten or twelve years, but during this time selections are to be made leaving the best trees, so that in the end very few defective trees need be left standing. While the young trees are developing, many

nuts may be gathered from them, as they begin to bear when three or four years old (Fig. 30). This is another advantage in having the young trees close together; they are allowed to remain in the orchard until they become too crowded, when the defective trees are used to supply scions, being trimmed closely every year. In a grove there is little danger of the young trees injuring themselves by being allowed to bear too early, although too many burs should not be allowed to remain on a young tree. The size of the fruit will be smaller, and the trees may be broken down by the weight of the nuts, or blown over by the wind. Often it is necessary to pick off nearly half the young burs to keep the trees from breaking down.

The number of burs that will mature on a young tree is astonishing. A four year old tree shown in Fig. 31 matured two hundred burs, many of them containing two and three nuts, and from this tree early in the same season (1902) three hundred young burs had been picked. Such a remarkable crop would have been impossible on a four year old seedling, as the roots have all they can do to obtain nourishment for the development of the tree, let alone the maturing of the fruit.

"Many mistakes have been made in grafting, and as it is a most important phase of chestnut growing, in fact, the basis of success, too much care cannot be given to this part of the work. If well done ninety per cent. of the grafts should live. An experienced man should set 250 scions per day, and do it well. In whip or tongue grafting the stock and scion should be of as nearly the same diameter as possible, and the cut on each long and smooth, and made with a thin, very sharp knife. Each should then be cut vertically so as to leave a wedge shaped piece on the face of each cut, so the tongue of the scion may be forced firmly into the cleft of the stock. The union should be exact, so the inner side of the bark on each will coincide at least on one side. The joint should be thoroughly waxed, and as a further precaution, wrapped tightly with waxed muslin. The muslin holds everything firm, thus hastening the union of the cambium layers. It excludes air from the cracks in the wax caused by the expanding sprout, and gives a mechanical support which prevents breakage of the joint by the wind. The yearly growth of grafts when thus treated is quite remarkable. When two months old they are often two to three feet in length, while it is recorded that one specimen grew in one year a linear distance of 54 feet, counting the main axis and all the lateral branches. The writer measured one graft which had been inserted 14 days and found it to be ten inches long. The first year's growth is inclined to assume a fan shaped form, and not make a well rounded crown; hence it has been found advantageous to cut back the first year's growth in the fall so that only a stub three

to four inches long, containing two to three buds, is remaining. The following year these buds will grow into a well-rounded head.

"An interesting fact is that many of the European chestnuts will grow equally well if grafted upon oak sprouts or seedlings. In France and England the chestnut has been grafted upon the English oak (*Quercus robur*) for years. In this country, the U. S. Division of Pomology found by experiment that several varieties of European chestnuts, including the Paragon, Numbo and Ridgely, grow well on our chestnut oak (*Quercus prinus*). In Central Pennsylvania the Paragon has been seen grafted upon red oak (*Quercus rubra*) with evident success. This adaptability of the chestnut to thrive on oak stocks materially increases its range and possibilities." E. A. Sterling, in Seventh Report of the Forest, Fish and Game Commission of New York State, 1903.

GRAFTING OUTFIT.

Mr. Sober's grafting outfit is seen in Fig. 22 and is such that everything can easily be carried in one hand. The wax used by Mr. Sober is from the old formula used by his father, and is made as follows:

Common resin,	2 pounds.
Beeswax,	1 pound.
Beef tallow,	$\frac{1}{2}$ pound.

Melt together in a convenient vessel, stir thoroughly, cool slowly, and as it cools, work up into rolls and wrap in oiled paper until wanted for use.

When making the wax, strips of old muslin are prepared, about three-fourths inch wide, and as long as desired. These are to be used in wrapping the grafts. The strips are wound tightly on corn cobs, by a device shown in Fig. 22, and then, while the wax is still hot, the roll is saturated by placing cob and muslin in it until all is thoroughly soaked.

Sometimes it is desirable to know the grafts inserted by the different grafters. Two methods may be used. Color the wax, or use colored calico in making the strips to be used in wrapping the joints. These wrappers must be made of old muslin or calico that will readily yield as the graft enlarges, otherwise they may girdle the tree. For this reason some prefer to use paper. A. S. Fuller says: "If to be used immediately (the wax) in grafting chestnuts and similar trees, then procure some sheets of tough manilla paper of only moderate thickness, and cut this up into sheets about six inches wide and a foot long. While the fresh made wax is melted, take an old and rather stiff paint brush, dip into the hot wax and coat the papers thinly with it, and then spread them out on shelves or elsewhere to

cool, and let them remain undisturbed until wanted for use. Any thin kind of cloth may be used instead of paper, but I prefer the latter because it will yield to the pressure of the enlarging stock and scion when growth begins, and it will not be necessary to examine the grafted stock so frequently during the summer to prevent girdling, as is usually the case when a tougher material is employed for wrappers. Before these waxed sheets are taken into the field for use, lay each one separately on a piece of board with the waxed side up, and with the point of a sharp knife cut them crossways into narrow strips of from one-half to three-fourths of an inch wide; but for convenience in handling, insert the knife a half inch from one edge, but cut the other clean through, so that the whole sheet of strips can be lifted together." This plan will do for one or two grafts, but is not recommended by Mr. Sober.

The knife is an important feature of the grafting outfit, and one cannot do better than to secure a grafter's knife; one with a blade from three to four inches long, flat on the under side. It should be of the best steel, and must be kept sharp. With such a knife a perfect union can be made. A pair of pruning shears is also necessary to be used in trimming the sprouts preparatory to the grafting. Mr. Sober always carries two pairs in his grafting box. The scions are placed in one side of the box and covered with sphagnum moss. A whetstone and razor strap complete the outfit. The grafters work singly and in pairs; when working together one will prepare and insert the grafts and the other will apply the wax and finish the process. The details of the grafting process are given with the description of Figs. 15-20.

GATHERING OR HARVESTING THE NUTS.

As the Paragon nut is slow in falling, and as it is desirable usually to gather the crop early in order to get the highest prices for the nuts, it is frequently, in fact, generally necessary to pick the burs from the trees by hand. A long pole with a fork at the end is used for this purpose, and is very successful while the trees are small. When the nuts are to be gathered from large Paragon trees, it may pay to wait a few days, as the heavy burs will soon fall. The collected burs are placed in the shade on a tight floor where they may be opened and the nuts removed. The larvae or worms which have infected the nuts will crawl out of many of them, and can be destroyed.

The nuts are assorted and the good ones sold immediately. The prices range from five to twelve dollars per bushel, but in a few years the prices may be lower. Even at \$2.50 per bushel they will pay better than wheat. We know very little now of the future of the

chestnut in America, and so will not prophesy. In this country the best methods for preserving the nuts on a large scale, have not been developed. The demand for them at present is so great that the few hundred bushels raised yearly by Mr. Sober can be sold as fast as gathered. In a few years the yield will be larger, and then methods must be devised for preserving them until they can be sold.

Experiments are being made upon the various methods recommended. One of the best seems to be to dry the nuts. "In Italy the custom prevails," according to Lodovico Piccioli, Silna, Italy, who is the author of 'Monografia del Castagna,' "of preserving the chestnut the whole year through in a very simple way. Immediately after gathering, the chestnuts are immersed in water which is renewed daily. At the end of the week the chestnuts are removed and dried in the sun and then kept in the driest place possible, so that their fine flavor may be preserved. The flavor is lost the moment they begin to sprout."

ECONOMIC VALUE OF THE CHESTNUT.

In the United States chestnuts are used mainly as a luxury, and we know very little of their value as a food. As it is, millions of pounds are imported every year from Europe. Rich and poor know and appreciate the delicate flavor of roasted or boiled chestnuts.

In Europe chestnuts of the first grade are usually sold, many of them being exported to the United States, and the nuts of inferior quality are made into flour. Chestnut flour has been known in Europe for centuries. According to Dr. Rothrock, the preparation of chestnut flour by the Italian, French and Spanish peasants is in general by the following method: "The nuts are first artificially dried. Generally this is done by leaving them for thirty or forty days before the household fire, in the hut as in Spain, or as in Italy, by drying or roasting them in deep trays under the roofs of special, small stone huts called 'matati' where slow, green wood fires are burning. The inferior nuts only are used for flour, the best variety being eaten fresh or exported. The chestnuts shrink to about one-third their original bulk in drying, turning yellow and becoming very sweet, and may be preserved for about a year. In Spain they are called "Pilongas" and are stored for winter consumption. When the dried nuts are intended for flour, the shells are removed; in Italy, by pouring into sacks while they are still hot from the drying, and beating them on a block of wood, or by pounding with poles having serrated iron heads. The shelled nuts are blanched, and are then called "white chestnuts," and may be stored for winter use or passed in commercial transactions or exported. The blanching consists in France of rubbing the

nuts around in a kettle of boiling hot water, with a "brigquette" which consists of two pieces of wood twenty-four to thirty inches long, joined like shears with a rivet and notched one foot up. The bleached nuts are dried and ground into flour." There is a great future for the chestnut in Europe, and the Governments are aiding the industry in every possible way.

Mr. Sober believes the future of the chestnut in Pennsylvania is as promising as in Italy, and E. A. Sterling says: "In this country the variety of food stuffs is so great, and their production so easy, that necessity has never taught us the value of nuts as food. The great grain fields of the west are looked upon as the one legitimate source of the 'Staff of Life,' yet the fact remains that chestnut flour makes an equally palatable and a more nutritious bread. The chestnut when raw is not easy to digest; but in cooking, the starch grains are broken up, making them readily digestible. Prejudice, coupled with ignorance and lack of appreciation of its good qualities, are the factors which to-day retard the adoption of the chestnut as one of our staple articles of diet.

"In chemical composition and relative food value, the chestnut differs widely from other nuts, since it contains a large percentage of the carbohydrates, especially starch, and less protein matter and oils. In this respect it quite closely resembles wheat flour. Since the carbohydrates are the chief source of the energy used in maintaining the vital process of the body, it follows that the chestnut, by reason of its high percentage of these carbohydrates, and the comparatively small amount of nitrogenous matter, is a better balanced and more nutritious food than other nuts, or even many of the cereals.

"It may be that when the wheat lands become less productive and the margin of profit lower, that men will turn to the idle, untilled woodlands of the east and utilize them for the production of nuts as a substitute for cereals. A change in our bread making material, if ever made, will come slowly, since public taste and long established customs are slow to alter, and new introductions are looked upon with distrust. The growing realization that the fine, white bread in use at present is lacking in nutriment, and is injurious to the digestive organs, and the general crusade against it by physicians and health food advocates, however, rapidly turns public attention to new cereals or substitutes for them.

"An acre of land will grow 35 bushels of wheat in a year if properly cultivated. A like area of chestnut trees will produce many times as many bushels of equally nutritious food yearly for an indefinite period, and require no outlay for cultivation, replanting or fertilization; more than this, the spring frosts, beating rains and summer

droughts, which are a constant menace to a wheat crop, work no injury upon the chestnut tree or its fruit. Why, then, is wheat grown on millions of acres, while we fail to produce even enough chestnuts to supply the now limited demand, and to allow southern Europe to exact large tribute from us annually for the nuts we import for consumption in their raw, unwholesome form? With the exception of the occasional Thanksgiving turkey stuffed with chestnut dressing, chestnuts in their many appetizing cooked forms seldom appear on the bill of fare of the American people; yet housewives are constantly complaining of the lack of variety in foods obtainable. Why not try chestnuts? Mrs. Rorer gives several excellent recipes which any cook can follow or enlarge upon at will. If given a fair trial, the chestnut cannot fail to commend itself for general table use, and when once generally introduced, new uses for it will be found, and its value placed among our valuable food products be assured."

CHESTNUTS AS FOOD.

There are no reliable data concerning the digestibility of nuts. The fact that many rodents live almost exclusively on them shows that they are valuable foods. Eating them at all hours and when the stomach is well filled with other food is a bad practice. In America we eat the nut after meals as a dessert, and between meals. We do not look upon the nut as a food. Chestnuts differ from most other nuts in that they contain less fat, and more carbohydrates, being also fairly rich in protein. When taken into the animal body, protein forms tissue, fats are stored as fats, carbohydrates are changed into fat, and the mineral matter (ash) aid in digestion and in forming bone, teeth, etc.

The methods of chemical analysis of foods are so nearly alike in all countries that reports from different chemists furnish a reliable means of comparing the composition of the various food products." From the following tables taken from Farmers' Bulletin No. 142, U. S. Department of Agriculture, "Principles of Nutrition and Nutritive Value of Food" by W. O. Atwater, Ph. D., Bulletin No. 114, Experimental Station Work, Bulletin No. 122, Experimental Station Work, and Pennsylvania Department of Forestry, 1961-1902, some interesting comparisons can be made as to the value and composition of certain nuts and food products.

Composition of Nuts and some other Food Materials.

(From Farmers' Bulletin, No. 122, U. S. Dept. of Agriculture.)

	Refuse.	Edible portion.	Composition and Fuel Value of the Edible Portion.					
			Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
Almonds,	64.8	35.2	4.8	21.0	54.9	17.3	2.0	*3,030
Brazil nuts,	49.6	50.4	5.3	17.0	66.8	7.0	3.9	3,329
Filberts,	52.1	47.9	3.7	15.6	65.3	13.0	2.4	3,432
Hickory nuts,	62.2	37.8	3.7	15.4	67.4	11.4	2.1	3,495
Pecans,	53.2	46.8	3.0	11.0	71.2	13.3	1.5	3,633
English walnuts,	58.0	42.0	2.8	16.7	64.4	14.8	1.3	*3,305
Chestnuts, fresh,	16.0	84.0	45.0	6.2	5.4	42.1	1.3	*1,125
Chestnuts, dried,	24.0	76.0	5.9	10.7	7.0	74.2	2.2	*1,875
Acorns,	35.6	64.4	4.1	8.1	37.4	48.0	2.4	2,715
Beechnuts,	40.8	59.2	4.0	21.9	57.4	13.2	3.5	3,263
Butternuts,	86.4	13.6	4.5	27.9	61.2	3.4	3.0	3,371
Walnuts,	74.1	25.9	2.5	27.6	56.3	11.7	1.9	*3,105
Cocoanut,	48.8	51.2	14.1	5.7	50.6	27.9	1.7	2,986
Cocoanut, shredded,		100.0	3.5	6.3	57.3	31.6	1.3	*3,125
Pistachio, kernels,		100.0	4.2	22.6	54.5	15.6	3.1	*3,010
Pine nut or pinon (<i>pinus edulis</i>),	40.6	59.4	3.4	14.6	61.9	17.3	2.8	3,364
Peanuts, raw,	24.5	75.5	9.2	25.8	38.6	24.4	2.0	*2,560
Peanuts, roasted,	32.6	67.4	1.6	30.5	49.2	16.2	2.5	3,177
Litchi nuts,	41.6	58.4	17.9	3.9	.2	77.5	1.5	1,453
Beefsteak,	12.8	87.2	61.9	18.9	18.5		1.0	*1,130
Wheat flour,		100.0	12.8	10.8	1.1	74.8	.5	*1,640
Potatoes,	20.0	80.0	78.3	2.2	.1	18.4	1.0	*385

*These values were calculated; unless otherwise indicated the fuel values were determined.

Average Composition of Common American Food Products.

(From Farmers' Bulletin No. 142, U. S. Department of Agriculture.)

	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
<i>Animal Food.</i>							
Eggs: Hens' eggs,	*11.2	65.5	13.1	9.3		0.9	635
<i>Dairy products, etc.:</i>							
Butter,		11.0	1.0	85.0		3.0	3,410
Whole milk,		87.0	3.3	4.0	5.0	.7	310
Skim milk,		90.5	3.4	.3	5.1	.7	165
Buttermilk,		91.0	3.0	.5	4.8	.7	160
Condensed milk,		26.9	8.8	8.3	54.1	1.9	1,430
Cream,		74.0	2.5	18.5	4.5	.5	865
Cheese, Cheddar,		27.4	27.7	36.8	4.1	4.0	2,075
Cheese, full cream,		34.2	25.9	33.7	2.4	3.8	1,885
<i>Vegetable Food.</i>							
<i>Flour, meal, etc.:</i>							
Entire-wheat flour,		11.4	13.8	1.9	71.9	1.0	1,650
Graham flour,		11.3	13.3	2.2	71.4	1.8	1,645
Wheat flour, patent roller process—							
High grade and medium,		12.0	11.4	1.0	75.1	.5	1,635
Low grade,		12.0	14.0	1.9	71.2	.9	1,640
Macaroni, vermicelli, etc.,		10.3	13.4	.9	74.1	1.3	1,645
Wheat breakfast food,		9.6	12.1	1.8	75.2	1.3	1,680
Buckwheat flour,		13.6	6.4	1.2	77.9	.9	1,605
Rye flour,		12.9	6.8	0.9	78.7	.7	1,620
Corn meal,		12.5	9.2	1.9	75.4	1.0	1,635
Oat breakfast food,		7.7	16.7	7.3	66.2	2.1	1,800
Rice,		12.3	8.0	.3	79.0	.4	1,620
Tapioca,		11.4	.4	.1	88.0	.1	1,650
Starch,					90.0		1,675
<i>Bread, pastry, etc.:</i>							
White bread,		35.3	9.2	1.3	53.1	1.1	1,200
Brown bread,		43.6	5.4	1.8	47.1	2.1	1,040
Graham bread,		35.7	8.9	1.8	52.1	1.5	1,195
Whole-wheat bread,		33.4	9.7	.9	49.7	1.3	1,130
Rye bread,		35.7	9.0	.6	53.2	1.5	1,170
Cake,		19.9	6.3	9.0	63.3	1.5	1,630
Cream crackers,		6.8	9.7	12.1	69.7	1.7	1,925
Oyster crackers,		4.8	11.3	10.5	70.5	2.9	1,910
Soda crackers,		5.9	9.8	9.1	73.1	2.1	1,875
<i>Sugars, etc.:</i>							
Molasses,					70.0		1,225
Candy,†					96.0		1,680
Honey,					81.0		1,420
Sugar, granulated,					100.0		1,750
Maple syrup,					71.4		1,250
<i>Vegetables:‡</i>							
Beans, dried,		12.6	22.5	1.8	59.6	3.5	1,520
Beans, Lima, shelled,		68.5	7.1	.7	22.0	1.7	540
Beans, string,	7.0	83.0	2.1	.3	6.9	.7	170

*Refuse, shell.

†Plain confectionery, not containing nuts, fruit or chocolate.

‡Such vegetables as potatoes, squash, beets, etc., have a certain amount of inedible material, skin, seeds, etc. The amount varies with the method of preparing the vegetable, and can not be accurately estimated. The figures given for refuse of vegetables, etc., are assumed to represent approximately the amount of refuse in these foods as ordinarily prepared.

Average Composition of Common American Food Products—Continued.

Food Materials (as Purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel value per pound.
Beets,	20.0	70.0	1.3	.1	7.7	.9	160
Cabbage,	15.0	77.7	1.4	.2	4.8	.9	115
Celery,	20.0	75.6	.9	.1	2.6	.8	65
Corn, green (sweet), edible portion,		75.4	3.1	1.1	19.7	.7	440
Cucumbers,	15.0	81.1	.7	.2	2.6	.4	65
Lettuce,	15.0	80.5	1.0	.2	2.5	.8	65
Mushrooms,		88.1	3.5	.4	6.8	1.2	185
Onions,	10.0	78.9	1.4	.3	8.9	.5	190
Parsnips,	20.0	66.4	1.3	.4	10.8	1.1	230
Peas (pisum sativum), dried,		9.5	24.6	1.0	62.0	2.9	1,565
Peas (pisum sativum), shelled		74.6	7.0	0.5	16.9	1.0	440
Cowpeas, dried,		13.0	21.4	1.4	60.8	3.4	1,505
Potatoes,	20.0	62.6	1.8	.1	14.7	.8	295
Rhubarb,	40.0	56.6	.4	.4	2.2	.4	60
Sweet potatoes,	20.0	55.2	1.4	.6	21.9	.9	440
Spinach,		92.3	2.1	.3	3.2	2.1	95
Squash,	50.0	44.2	.7	.2	4.5	.4	100
Tomatoes,		94.3	.9	.4	3.9	.5	100
Turnips,	30.0	62.7	.9	.1	5.7	.6	120
<i>Vegetables, canned:</i>							
Baked beans,		68.9	6.9	2.5	19.6	2.1	555
Peas (pisum sativum), green,		85.3	3.6	.2	9.8	1.1	235
Corn, green,		76.1	2.8	1.2	19.0	.9	430
Succotash,		75.9	3.6	1.0	18.6	.9	425
Tomatoes,		94.0	1.2	.2	4.0	.6	95

Composition of the Chestnut and other Foods.

(From Farmer's Bulletin No. 114, U. S. Department of Agriculture.)

Variety and Condition.	Refuse.	Water.	Protein.	Fat.	Total carbohydrates.	Ash.
Chestnuts:						
Edible portion—	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Numbo, fresh,*	42.2	6.1	6.6	43.3	1.8	
Moon Seedling, fresh,*	41.7	6.3	6.4	43.8	1.8	
Solebury, fresh,*	29.2	6.7	8.3	54.0	1.8	
Native, fresh,*	34.4	8.0	10.8	45.1	1.7	
Italian, fresh,†	53.8	6.6	2.0	36.9	.7	
Italian, fresh,†	52.7	4.1	2.0	40.4	.8	
Variety unknown, fresh,‡	44.9	7.3	8.0	38.3	1.5	
Average fresh nuts,	42.7	6.5	6.3	43.1	1.4	
Spanish, dry,*	6.6	9.0	6.6	75.0	2.8	
Paragon, dry,*	6.5	11.4	9.1	70.1	2.9	
Spanish, dry,*	5.4	10.3	9.1	72.5	2.7	
Native, dry,*	4.8	11.6	15.3	65.7	2.6	
Average, dry nuts,	5.8	10.6	10.0	70.8	2.8	
As purchased—						
Numbo, fresh,*	11.5	37.3	5.4	5.9	38.3	1.6
Moon Seedling, fresh,*	14.3	35.7	5.4	5.5	37.5	1.6
Solebury, fresh,*	15.3	24.8	5.7	7.0	45.7	1.5
Native, fresh,*	23.2	26.4	6.2	8.3	34.6	1.3
Italian, fresh,†	15.4	45.5	5.6	1.7	31.2	.6
Italian, fresh,†	15.5	44.5	3.5	1.7	34.1	.7
Average, fresh nuts,	15.9	35.7	5.3	5.0	36.9	1.2
Spanish, dry,*	21.5	5.2	7.0	5.2	58.9	2.2
Paragon, dry,*	23.9	5.0	8.7	6.9	53.3	2.2
Spanish, dry,*	25.3	4.0	7.7	6.8	54.2	2.0
Native, dry,*	22.9	3.7	8.9	11.8	50.7	2.0
Average, dry nuts,	23.4	4.5	8.1	7.7	54.2	2.1
Wheat flour,§		12.8	10.8	1.1	74.8	.5
Cabbage:						
Edible portion,§		91.5	1.6	.3	5.6	1.0
As purchased,§	15.0	77.7	1.4	.2	4.8	.9
Potatoes:						
Edible portion,§		78.3	2.2	.1	18.4	1.0
As purchased,§	20.0	62.6	1.8	.1	14.7	.8

*Pennsylvania Sta. Bul. 16, p. 15.

†California Sta. Rpts. 1895-96; 1896-97, p. 153; Bul. 113, p. 7.

‡Massachusetts State Sta. Rpt. 1893, p. 354.

§U. S. Dept. Agr., Office of Experiment Stations Bul. 28 (revised).

Chestnuts are rich in carbohydrates (starch), and contain large amounts of protein and fat; comparing the chestnut with flour from the various cereals, it is seen that they are relatively rich in nourishment.

On the proportions of nutriment in foods, Dr. W. O. Atwater says:

"The most important of the actual nutriment has been seen to be protein. This occurs most abundantly in animal foods—meat, fish, eggs and dairy products, and in the dried legumes, as beans and peas. Butter and lard are exceptions to this statement, as they rep-

resent the fat of milk and meat. The proportion of protein present in meats and fish varies greatly with the kind and cut. In beef, veal and mutton it composes between 14 and 26 per cent. of the edible portion. It is generally less abundant in the flesh of fish, because the latter is more watery than meat. The fatter the meat, the smaller is the proportion of protein; lean pork has less than beef and mutton, and fat pork almost none. It is more abundant in cheese (28-38 per cent.) and likewise in dried beans and peas (18-25 per cent.) Protein makes up, roughly speaking, from 7 to 15 per cent. of the cereals, being least abundant in rye and buckwheat, and most abundant in oats. Wheat flour averages not far from 11 per cent. and bread not far from 9 per cent. of protein. Fresh vegetables and fruits contain almost no protein, seldom if ever more than 5 and often only 1 per cent. or less."

THE PARAGON CHESTNUT ; ITS FOOD VALUE, HOW TO GROW IT, ETC.

Paragon chestnuts, when dry, average 11.4 per cent. protein, which is more than wheat flour. As the most abundant nutriment in chestnuts is starch, it is interesting to note what Dr. Atwater says concerning it:

CARBOHYDRATES.

"These include such compounds as starches, different kinds of sugar, and the fiber of plants or cellulose. They are found chiefly in the vegetable foods, like cereal grains and potatoes; milk, however, contains considerable amounts of milk sugar, which is a carbohydrate. The carbohydrates form only a very small proportion of the body tissues, less than one per cent. Starches and sugars, which are very abundant in ordinary food materials, are important food ingredients, because they form an abundant source of energy, and are easily digested. They may be and often are transformed into fat in the body.

"Fats and carbohydrates are the chief fuel ingredients of food. Sugar and the starch of bread and potatoes are burned in the body to yield heat and power. The fats, such as the fat of meat and butter, serve the same purpose, only they are a more concentrated fuel than the carbohydrates.

"The body can also transform carbohydrates of food into fat. This fat, and with it that stored from the food, is kept in the body as reserve fuel in the most concentrated form.

"The different nutrients can to a greater or less extent do one another's work. If the body has not enough of one kind of fuel it can use another. But, while protein can be burned in the place of fats and carbohydrates, neither of the latter can take the place of the albuminoids in building and repairing the tissues. At the same time the gelatinoids, fats, and carbohydrates, by being consumed themselves, protect the albuminoids from consumption."

INSECT PESTS.

The chestnut is not free from enemies and the success of the chestnut in America will largely depend upon whether the insects which feed upon the nut and bur can be controlled. At present extensive experiments are being made which aim to prevent the maturing of the larvæ in and near the orchard. The weevil is not the only insect enemy, and perhaps not the most injurious. At least two larvæ feed upon the bur or husk, and from what we have seen

during the past two years, these are the ones to be especially feared. These insects have not as yet been controlled in America. The best plan thus far tried is to remove all chestnuts and burs from the orchard as soon as the nuts are ripe. The burs are burned as soon as the nuts are removed, and the nuts are assorted, the defective ones being destroyed. Fire, wind, rain, hail and thieves are enemies which may be controlled in part or wholly, but the future of the improved chestnut in America is dependent upon whether or not the insect pests can be controlled.

CONCLUSION.

In concluding, we cannot do better than quote from Farmers' Bulletin No. 114, U. S. Department of Agriculture, 1900:

"European chestnuts were first grown in this country in the early part of the nineteenth century. Japanese chestnuts were introduced at a much later period. The first importations are said to have been made about 1876. The advent of the Japanese nut, with its large size, early bearing propensities and complete union on either its own or American-grown seedlings or native American stocks, at once attracted the attention of prominent horticulturists to the possibilities of a new and desirable industry. As a result both groves and orchards have been set out in the Eastern States and California, covering, in some instances, more than 100 acres in extent and numbering thousands of trees.

"Chestnuts are usually propagated from seed and the stocks later grafted or budded with improved varieties. Seed for this purpose can be planted in the fall soon after the nuts are ripe, or kept over until spring and then planted in the seed bed in light sandy soil or pure leaf mold. Seed nuts should not be allowed to become dry after being gathered, and when kept over winter they may be preserved in a box alternating in single layers with moist sand. Holes should be made in the bottom of the box to allow excess moisture to escape. The top should be covered with wire netting to avoid the ravages of rodents, and the whole placed in the open ground, some knoll or other spot being selected for this purpose, and the box buried about six or eight inches deep.

"When possible, it is best to plant the seed where the tree is expected to grow, since the long tap root of the chestnut renders it somewhat difficult to transplant. Otherwise the seeds are planted in a seed bed in rows wide enough apart to permit of easy cultivation. The following spring they may be planted in the nursery in rows four feet apart, and about 18 inches distant in the row. In transplanting, the tap root should be pruned back to about one-half its length and all side branches of the stem removed. Frequent cultivation should follow during the summer.

"It is generally advisable to allow the stocks to remain in the nursery rows at least two seasons before they are grafted, or until they have attained a size of from three-eighths to one-half inch in diameter, 3 or 4 feet from the ground. Valuable stocks can often be secured from natural seeding in the forest or from the sprouts of cut-over chestnut lands; in fact, the usual method of growing chestnuts on a commercial scale is by grafting the sprouts arising about the stumps of such forests with the European or Japanese varieties.

"At the Connecticut State Station the best time for grafting was found to be from May 15 to June 15. Whip grafts on small stocks made the best union. Cleft grafting is desirable for large stocks. Foliage should be left around the graft to protect it from the sun's rays. When the grafting is skillfully performed, it can be reasonably expected that about 50 per cent. of the scions will grow.

LOCATION.

"The chestnut orchard should be located on well-drained gravelly soil for best results. It succeeds well on rocky hillsides with soil of sufficient looseness and depth, and with either a northern or eastern exposure. It will thrive on rather poor land, but is slow and uncertain on stiff, clayey soils, although excellent results are reported from the California Station with Italian chestnuts on heavy clays. In general it is considered more important to have a thoroughly drained soil than soil of a particular character.

"Trees in the permanent orchard, when of the European variety, should be set not less than 40 feet, and when of the Japanese, not less than 30 feet apart each way. They are usually pruned to an open spreading form, with three to five main branches, and cultivation given similar to that of a young apple orchard.

"Grafted chestnut trees grow rapidly and Japanese varieties frequently set fruit the first year of the insertion of the scion. Both Japanese and European varieties frequently bear heavy loads of burs the second year. It is advisable to pick off all fruits for the first three or four years in order that the energy of the tree may be devoted to the production of a vigorous growth of wood and a well-established root system before reproduction begins.

MARKETING.

"Nuts are prepared for the market by first plunging in scalding water for fifteen minutes and thoroughly stirring. The wormy nuts rise to the top of the water and are removed, after which the water is drained off and the nuts dried in the sun or in the drying house to prevent molding. It is advisable to grade nuts for the general

market, as the price of a lot is regulated by the size of the smallest nuts.

INSECT ENEMIES.

"The chestnut tree has a number of insect enemies which attack the leaves and wood; but apparently the most serious injury is done by weevils which work in the fruit. The Delaware Station suggests as one of the means of controlling these insects that orchards be planted away from native chestnut forests; all worms and wormy nuts destroyed; the beetles caught by jarring, as for the plum curculio; and a few trees planted in the orchard which attract the weevils, all the fruit from these trees being destroyed.

HARDINESS.

"It is claimed that Japanese varieties are less affected by fungus diseases than European and American varieties, which are frequently total failures from this cause. Experiments at the Delaware Station indicate that one of the most troublesome of these diseases, viz, leaf blight, may be controlled by spraying trees with three or four applications of Bordeaux mixture. A disease similar to sunscald sometimes affects trees in the nursery. Imported seedlings appear to be especially liable to this disease; hence, it is best to grow European and Japanese seedlings in America."

DESCRIPTION OF ILLUSTRATIONS.

Fig. 1.—Portrait of Coleman K. Sober, of Lewisburg, Pennnsylvania, owner of Chestnut Grove Stock Farm. Mr. Sober succeeds because after having once begun a task, he will not leave it until he has seen it successfully finished. He is not easily discouraged, and always sees a thing clearly in his mind before beginning it. Having once satisfied himself that he is right, no one can discourage him.

The methods given in this Bulletin were developed independently by Mr. Sober, and are recommended especially for the Paragon chestnut. The results agree very closely with those reached by Mr. Andrew S. Fuller, which are described in the "Nut Culturist," 1896 (Orange Judd Company, New York). Where their methods are identical I have in several instances quoted from Mr. Fuller. Due credit should be given to each, as the methods were evolved by each one only after long experience.

Fig. 2.—Chestnut Grove Stock Farm. The buildings are lighted by acetylene gas, have hot and cold water, and in fact every convenience to be found in the city. It is a handsome country estate. In the lower right-hand corner of the photograph the edge of the half-mile race track is seen. Mr. Sober has about twenty-five blooded race horses, most of which are as well bred as any in the United States.

Fig. 3.—In one of Mr. Sober's Chestnut Groves. The trees have been grafted for three or four years, and from most of them two crops of chestnuts have been gathered. Of course, only a few nuts matured the first year they bore. In order to insure a good, permanent stand of perfect trees, the sprouts were grafted very close together. The defective trees are removed from time to time.

Fig. 4.—Paragon chestnuts, natural size. The burs were placed in the shade for a few days, to open, and so were somewhat contracted. Three is the average number of nuts in one bur. If the tree contains too many burs, frequently only one will mature in each bur; this, however, is usually a large one.

Fig. 5.—Paragon, natural size. The circle is the size of a five cent piece, and is shown for comparison.

Fig. 6.—Paragon, natural size. It is unusual to find seven perfect nuts in one bur.

Fig. 7.—The chestnuts shown in this photograph were selected

from two quarts of nuts taken from a sack just as they were gathered, without any assorting.

Fig. 8.—As soon as the nuts begin to turn brown in the burs they may be gathered. In Pennsylvania this occurs the last week in September or the first week in October. The Paragon bur is slower than the native in opening, and usually the burs fall to the ground when ripe, where they remain closed for several days, finally opening enough to allow the nuts to be picked out. In harvesting, the nuts and burs are removed from the grove as soon as possible. By shaking the trees the burs will fall to the ground almost as readily as apples; this is the best way to control the insect pests, as bur worms and developing weevils will then be removed and readily be destroyed. The burs are spread out on the ground in layers not over ten or twelve deep, where they will open in a few days. As soon as the burs open, the nuts are picked out and cared for while the burs are burned, in order to destroy the larvæ of the insects which attack the bur.

Fig. 9.—As soon as the burs begin to open, men wearing gloves for protection, remove the nuts from the burs. The pile shown in the photograph contained over one hundred bushels of perfect chestnuts.

Fig. 10.—E. A. Sterling says: "To summarize, under the head of the American chestnut, it may be said that on the whole the attempt to improve its quality by cultivation, and its range by planting or transplanting, have proved unprofitable. The nuts produced are too small, and the time required for a tree to come into bearing too long to induce a hustling American to grow it for the nuts alone. Its greatest value for nut culture lies in its root sprouts, which furnish most excellent 'stocks' upon which to graft the most desirable European varieties. As a shade and timber tree, or source of nuts for home or local consumption, it will always hold an esteemed place with the American farmer, but the horticulturist or orchardist who wishes to produce nuts on a large scale must turn to the larger, more rapid growing European and Japanese varieties, or greatly improve the native nuts, if success is to be assured."

Fig. 11.—The original stump has almost entirely rotted away, in the center; around it are seven stumps, the second generation; around these are sixteen trees, the third generation, and all are at least one foot in diameter at the distance of three feet from the base.

In the Forestry Report of Pennsylvania, issued in 1895, the following reasons are given for the cultivation of the chestnut:

"1. It grows with great rapidity.

"2. It will grow on almost any kind of soil, from a river flat to a mountain top, although it is not at its best on limestone soils.

"3. When cut it reproduces a valuable coppice growth in a few years.

"4. Its product, wood and fruit, will always be in demand.

"5. There will be an increasing demand for it in the future because of the tannin which it contains."

Fig. 12.—For a few years nearly all the sprouts which start around a chestnut stump should be allowed to grow. Two or three should be grafted, and others left for protection. There is another reason, however, which is usually not thought of, and yet it is very important. Unless there are enough leaves on the sprouts to keep the root system at work, the root will rapidly die. If all the sprouts be cut away except those grafted, no leaves will be left and the grafts, although they start, will soon perish because of the injury to the roots. The graft is usually kept trimmed for two years, and during this time the old root system perishes.

Fig. 13.—The sprouts shown were the only ones to start around the old stump. All were grafted and grew rapidly for one year. During the second year they died because the root system did not have enough leaves to keep it alive.

Fig. 14.—Paragon graft on native sprout, one year old. The tapes show where to cut it back in order to produce a well-rounded head. If allowed to grow it will bear nuts the second year.

Fig. 15.—"Cleft" or "wedge" grafting. The method used by Mr. Sober is practically the same as that described by Fuller, in the "Nut Culturist," so I quote the following:

"Cleft grafting.—This method is employed principally upon stocks or branches of trees too large for splicing. The stock is first cut off at the point where it is desirable to insert the scion; then split with a knife, being careful to divide it so that the edges will be kept smooth, and not rough and ragged. When the knife blade is withdrawn, the cleft may be kept open with a hard wood wedge, if the stock is too large to admit of opening with the point of the knife when ready to insert the scion. The scion may be three or four inches long, containing two or more buds; the lower end is cut wedge shape, and slightly the thickest on the side to be set against the bark of the stock. In stocks of an inch or more in diameter, two scions, one on each side, may be inserted, and if both grow, one should be cut away, else the tree in later years, will be very likely to divide or break apart at this point. In stocks of an inch or less in diameter, one scion is sufficient, the top of the stock to be cut off with an upward slope (as shown in Fig. 15). After the scions are inserted, the entire exposed surface of the wood must be covered with grafting wax, or waxed paper, and usually both may be employed with benefit."

Fig. 16.—A cleft graft four years after being inserted. The scion and stock are now of the same diameter, and the union can scarcely be detected.

Fig. 17.—Mr. Sober seldom uses this method of propagation. Budding during the summer months has not proved successful. It is better to wait until the following spring and then use another method. Wrapping with waxed muslin after inserting the bud is a decided advantage.

Fig. 18.—When the bud is used on young sprouts the point of union can be detected for a long time, and frequently a defect will remain when the stock was cut off.

Fig. 19.—The splice or whip graft.—Mr. Sober's method of inserting this graft is practically the same as that described by Fuller, except that he does not recommend the waxed paper; in its place he uses waxed muslin or calico. His objection to paper is its inconvenience on warm days. Fuller says: "In the splice graft, the scion and stock should be of about the same diameter, but if there is any difference let it be in favor of the stock, and this the largest. In this mode of grafting, the stock is cut off with an upward slope, exposing two or three inches of wood; and about midway on this slope a small cleft or incision is made, forming what is called a "tongue." The scion is then cut in the same way from the upper end downward, with corresponding incision. Then the two are neatly fitted together, the tongue on one entering the cleft on the other, making a close joint. The bark of the scion and stock should be exactly even on one side at least; and if they are of the same size, so much the better, for then they will be even on both sides; but we cannot expect to secure such perfect joints on every stock, or any considerable number, although we aim to do so as frequently as possible. When the scion is fitted, the waxed paper (old muslin or calico is used by Mr. Sober) is applied by placing one end of the strip at or near the base of the splice, then wind it spirally and firmly upward until the entire wound is covered. If one of the waxed strips is not enough, use another, for it will do no harm if they are double on a part or all over the joint. The scion should not be much over four inches long, and a less length is preferable, but not so convenient for handling. One good, prominent bud on each scion is sufficient, and this is left near the upper end, but on short jointed wood we may use scions with two or more buds without greatly increasing their length. After the scion is placed and every part of the splice is carefully sealed with the waxed paper, place a small piece or a little wax on the upper end of the scion, just enough to cover the exposed wound and prevent evaporation of the natural moisture or sap in the wood. I have found in practice, that this sealing of the end of the scion is

time well spent; in fact, to leave any of the woodcells exposed to the air endangers the success of the operation.

"Young shoots from a quarter of an inch in diameter up to five-eighths may be used for scions in splice grafting; and with a little care in the selection of stocks, or by cutting them off a few inches higher or lower, we may readily manage to have them nearly of the same diameter to match, whether they are large or small, and such unions will soon heal over, leaving no scar at the point where the two have been joined."

Fig. 20.—The whip or tongue graft. In the middle figure, the splice as first made, and, in the other figures, at the end of one season's growth. A callus is formed between the stock and the scion, each taking a part in the formation. In this callus the vessels are formed connecting the like parts in stock and scion.

Fig. 21.—Tongue graft three years old. For a few years the scion increases more rapidly in diameter than the stock, but later the point of union can scarcely be detected, and the tree becomes well balanced.

Fig. 22.—The grafting outfit is simple, and can easily be carried by one man. It contains bars of grafting wax, rolls of waxed muslin, pruning shears, grafting knife, razor strop, water and scions. The scions are kept moist and clean. In one corner of the box is a little tallow to place on the fingers when they become too much covered by wax. The joint between the stock and scion is kept perfectly clean by Mr. Sober, and no oil, tallow or other substance is allowed to come into contact with their cut surfaces. To accomplish this the hands must be kept clean. Mr. Sober prefers one man to do all the fitting and placing of the grafts, and another for the applying of the wax.

Fig. 23.—This figure shows plainly why hundreds of grafts in Mr. Sober's grove have failed to develop. The men employed during the summer to remove all buds from the stock below the graft have failed, and as a result the buds, being well established, get all the nourishment and the graft dies. At least three times during the first season the buds and sprouts are removed from the stock.

Fig. 24.—Sections of the points of union in whip grafts. Unless the joint is well made, water gets into it and a defective union will result.

Fig. 25.—A defective joint. One side healed perfectly, but the other remained a weak point. Such a joint may in time become perfect, but in making improvement cuttings, they are nearly all removed and only the best trees allowed to stand.

Fig. 26.—When the trees are three years old the grove is cleaned thoroughly; all native sprouts not grafted are cut from the stumps. These with brush, dead logs and leaves are burned. After this clearing, the grove is ready for sheep.

Fig. 27.—The grove was cleared during the fall and winter of 1903-4 and in the spring of 1904, five hundred sheep were placed in about ninety acres of the grove. These have all they can eat, and are rapidly clearing the grove.

Fig. 28.—The trees are not injured by the sheep except an occasional one which may be scarred by the horns or broken by constant rubbing, at those portions of the grove where the sheep gather at mid-day.

Fig. 29.—Mr. Sober prefers to have low crowns. The graft is not so apt to be broken off by the wind, and the nuts may be more easily gathered when the trees become older. To secure a low crown it is necessary to trim the tree at the end of the first season's growth. This may be done in the fall after the growth has ceased, and the wood has ripened.

Fig. 30.—A three year old tree containing about one hundred burs. As the nuts ripen the burs fall to the ground without opening. After three or four days they have opened far enough to allow the nuts to be picked out.

Fig. 31.—It is not best to allow too many burs to remain on the trees. If part are picked off, the others will be larger and more perfect.

Fig. 32.—The branches on a large tree may be grafted by using the wedge graft, but it is better in the end to cut the tree down, and graft the sprouts which arise from the stump.

Fig. 33.—Chickens and guineas will find their own food in the chestnut grove. Mr. Sober has hundreds of chickens in one grove, but just how many injurious insects, and insect larvae they will consume, is a question. It is certain that they devour many weevils when they leave the ground in passing from the pupa to the adult stage. In the chestnut grove it is hard to protect the chickens from enemies, and only a few eggs can be gathered. Guineas seem to be more of a success than chickens, as they will bring to maturity more young than the chickens, and are better able to find food.

Fig. 34.—In Pennsylvania and other Northern states the chestnuts should not be planted until spring. The long, cold winters frequently destroy the nuts if planted in the fall. In 1903 Mr. Sober planted about 16 bushels of nuts late in the fall. During the winter the temperature was as low as 33 degrees F., below zero, and frequently 20 degrees F. below zero. In the Spring, nearly every nut had failed to sprout, while nuts buried in boxes and protected from the cold by being covered with cornstalks, sprouted, as shown in the figure. The nuts were left in the boxes until the sprouts which were to become the tap roots had reached three or four inches in length, when it was cut off close to the nut and planted.

Fig. 35.—This figure shows the result of cutting of the tap root sprout before the nuts are planted. The seedling at the left was so

treated, while the other two were not. Notice the great number of small roots where the sprout was cut off, and the long tap roots in the others. The seedling with many fibrous roots may easily be transplanted without danger, while the other two may stand transplanting but the chances are not in their favor, as it is very hard to remove such a seedling without tearing off the delicate roots which have started along the tap root.

Fig. 36.—Instead of cutting off the tap root sprout when the nut is planted in the spring, it may be placed in a horizontal position as was done with the seed from which the seedling shown on the right in the figure was grown. Numerous fibrous roots will start all along the original tap root.

Fig. 37.—In the "Statement of work done by the Pennsylvania Department of Forestry" during 1901 and 1902, is an article by Forester, Wirt on the "Propagation of Forest Trees," which contains paragraphs on transplanting, which applies very well to the chestnut. He says: "Transplanting can be done either in fall or in spring. If done in the fall, it should be after the growth has ripened or ceased. During the winter the dirt will have a chance to settle around the roots, and by spring the loss of root fibre will be partly made up. On the other hand, frost may lift the plants out of the ground, or storms may loosen them. Then, too, they will be exposed to damage from animals at a time when food is scarce. In spring, work should be done as early as possible, at least before the new growth begins."

"Roots.—There are numerous methods of planting, but in all the most important thing is to take care of the roots. Perhaps more failures could be traced to lack of care of them than to any other cause. They are very sensitive to sun and wind and should never be exposed long enough to be dried out. When the plants are removed from the nursery, they should be taken from the beds as carefully as possible so that very few roots be broken. Wrap the roots in wet burlap or cover them with moist moss, or place them in thin mud. The plants may then be carried safely to the place of planting. If this is not done at once they should be "heeled in." In planting do not cramp the roots in any way, and see that the growing ends are down and not up. Place fine soil among the roots and pack it thoroughly; if sod has been taken out, turn it upside down on the ground, close to the tree. Young plants are sensitive to being planted too deep and so should not be deeper than they were in the nursery. When large roots have been broken or bruised, they should be cut off smooth with a sharp knife. Planting can not be done too carefully."

With chestnut seedlings, either from native or Paragon nuts, it is necessary to graft them before transplanting. This is done either the second, third or fourth year after planting. Mr. Sober prefers the splice graft seedlings.

Fig. 38.—All nuts and burs are removed from the grove as soon as they fall to the ground. Defective nuts and all burs are burned and thus many larvae are destroyed. From one nut I have removed over 25 larvae of weevils. Care should be taken that none of these reach the ground.

Fig. 39.—Naturally, the larvae of the chestnut weevil leave the nut during the fall, and bury themselves in the ground, where they remain until the next June, July or August. Most of them, however, transform to pupae during June and July. They remain in the pupa stage for three or four weeks and then emerge as adults. The adults deposit their eggs in the nuts during August and September.

Fig. 40.—The habits of the adult weevil are being studied from year to year, and we hope soon to be able to learn the best methods for destroying them. The method which has proven best, thus far, is to keep the larvae from developing.

Fig. 41.—The long beak of the female weevil enables her to pierce the nut while it is still in the bur, and with it she probably deposits the eggs in a manner unknown to me.

Fig. 42.—The bur shown in this figure was pierced in early September, and the weevil was killed with its beak still in the nut. Eggs had already been deposited in the nut. The scar made in the seed-coat soon heals up, and in many nuts it is impossible to find it afterwards.

Fig. 43.—The life history of the "bur" worm is unknown. The adult is probably a moth. It is one of the worst enemies of the Paragon. The larva feed on the husk of the nut or bur, and frequently enter the nut, leaving an ugly wound. The larva soon returns to the bur, apparently not liking the taste of the nut. If used at once, the nut is scarcely injured by the worm, but it, of course, cannot be sold.

Fig. 44.—The nuts injured by the "bur" worm will soon mould, and thus contaminate the entire pile. If these nuts are separated from the others as soon as gathered, and used at once, they may be saved.

Fig. 45.—When trees are heavily loaded with fruit, those in which the union of the graft is defective, are frequently blown over by the wind. If there is no other tree near it, such a tree is allowed to stand as long as it will.

Fig. 46.—In the region near Mr. Sober's chestnut groves, meadow mice are very scarce. An occasional tree is girdled by them during the winter. In Union county, Pa., however, the meadow mouse is very abundant, and has proved one of the worst enemies to young trees of any kind; even forest trees, such as pine and hemlock are frequently destroyed by the hundreds, and I have seen locust trees a foot in diameter completely girdled by them.





Fig. 2.—Chestnut Grove Stock Farm.



Fig. 3.—The Chestnut Grove. Three years old.



Fig. 4.—Paragon Chestnuts—Natural size.

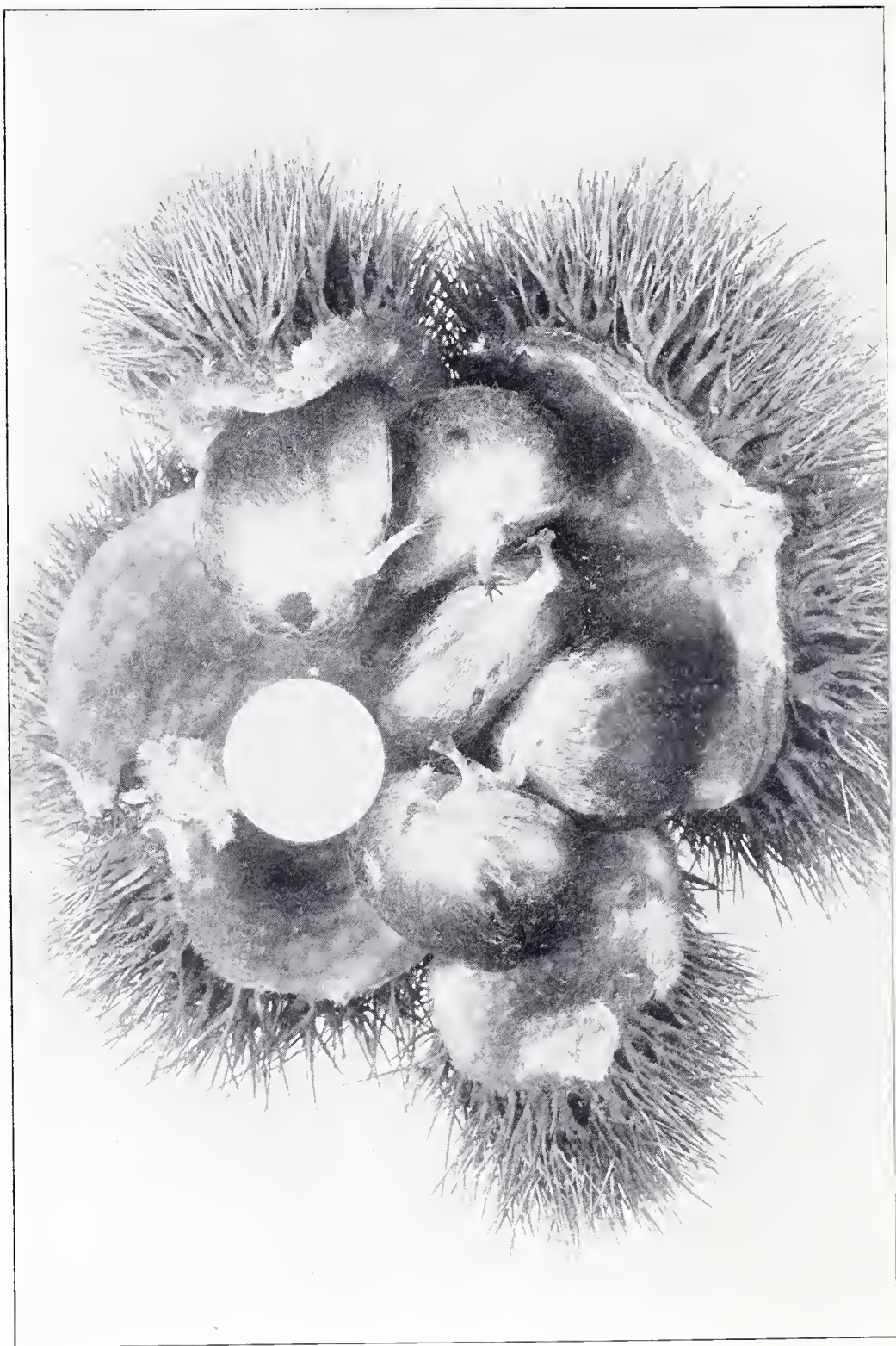


Fig. 5.— Paragon Chestnut Bur with Nuts; Natural size.



Fig. 6.—Paragon Chestnuts—Natural size.



Fig. 7.—Nuts 1-5 are covering 50 cent pieces. Nut No. 6 is covering a silver dollar. Seven nuts measure 10 inches.



Fig. 8.—Harvesting, 1902.

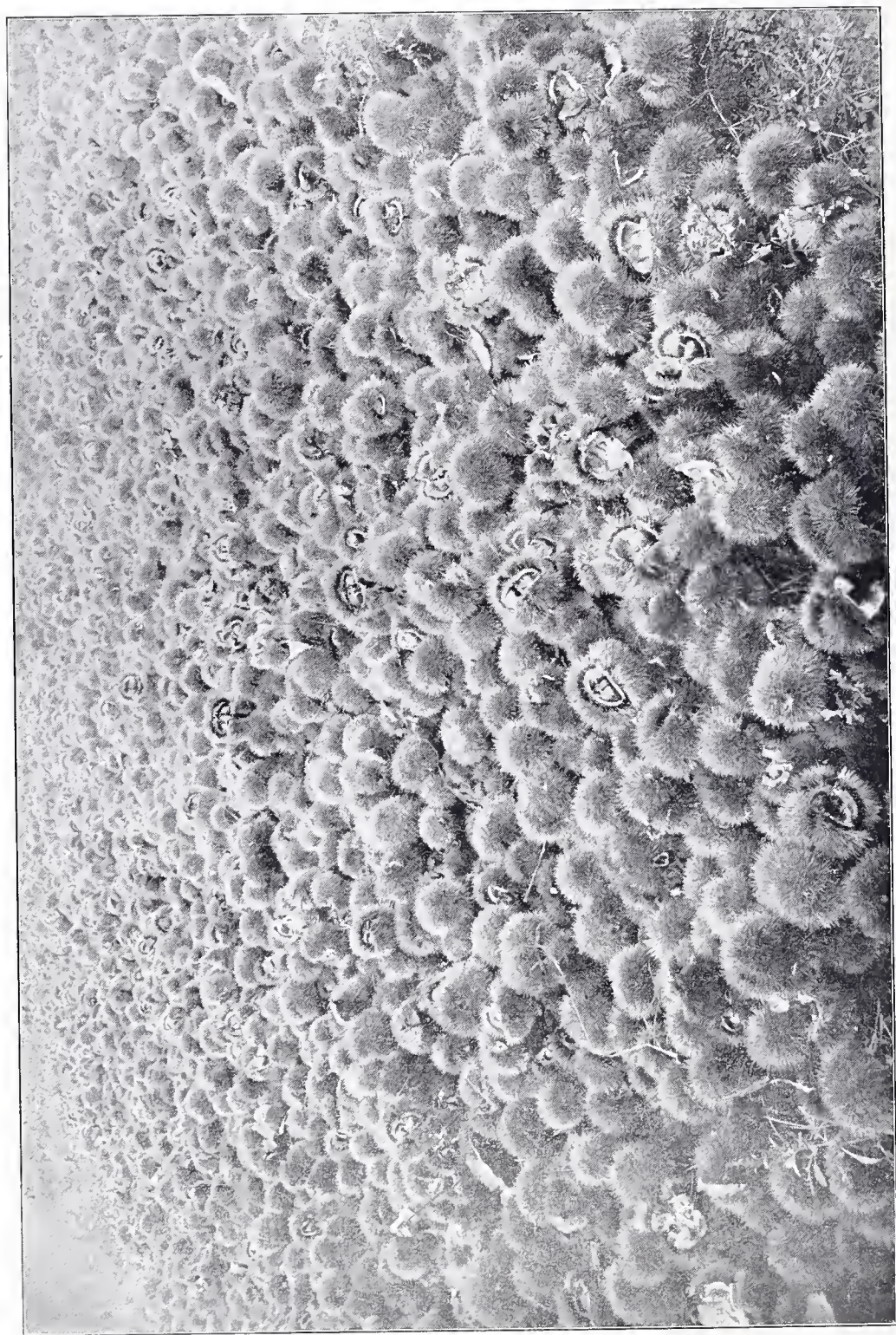


Fig. 9.—Chestnut burs spread on the ground to dry.



Fig. 10.—Native chestnut forest, Long Island, N. Y.



Fig. 11.—Third growth native chestnut trees around old stumps, Long Island, N. Y., 1903.



Fig. 12.—Sprouts before and after grafting.



Fig. 13.—Grafts inserted June 10, 1902.] Photograph taken October, 1902.

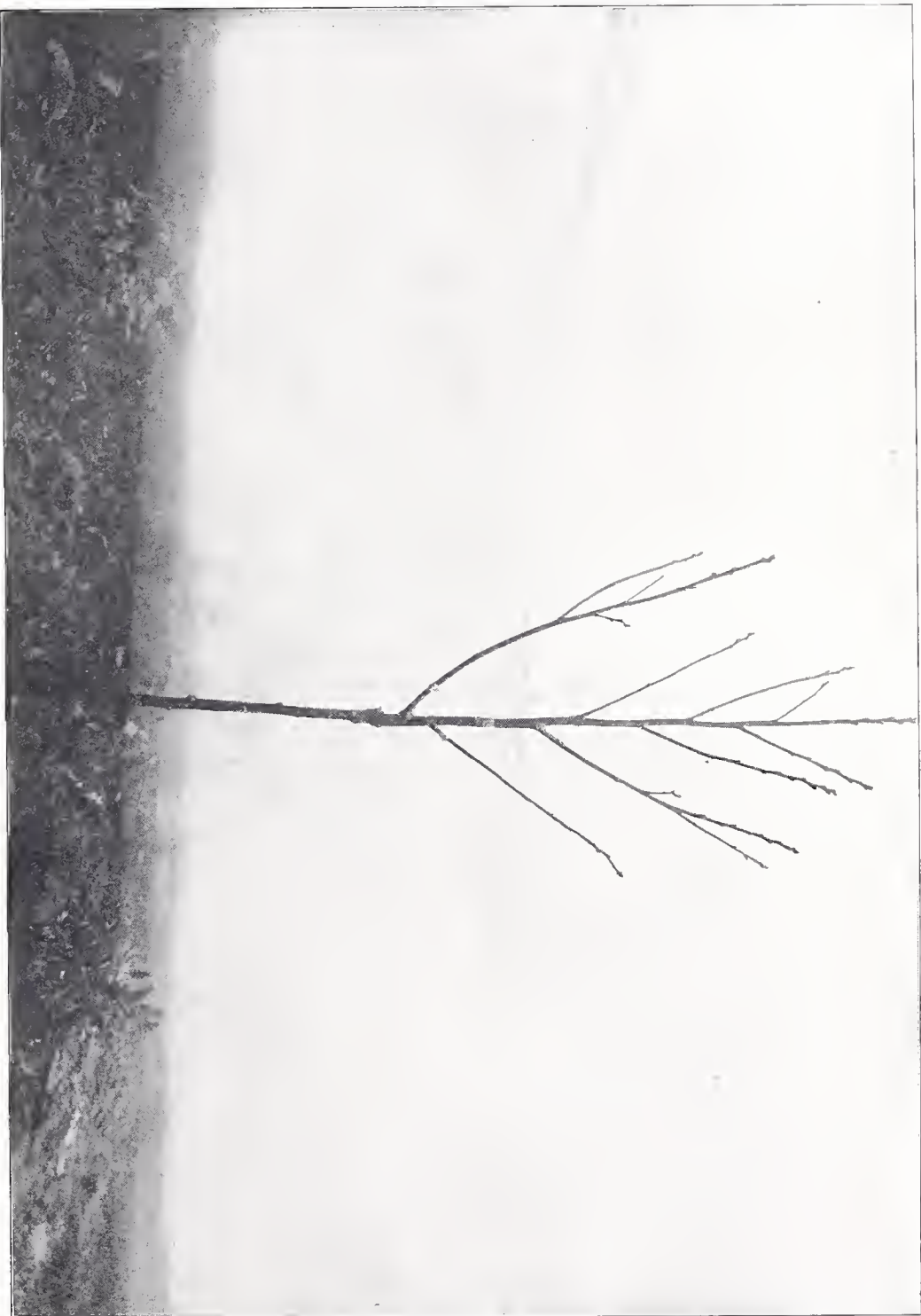


Fig. 14.—Graft one year old. The tapes show where to cut it back.

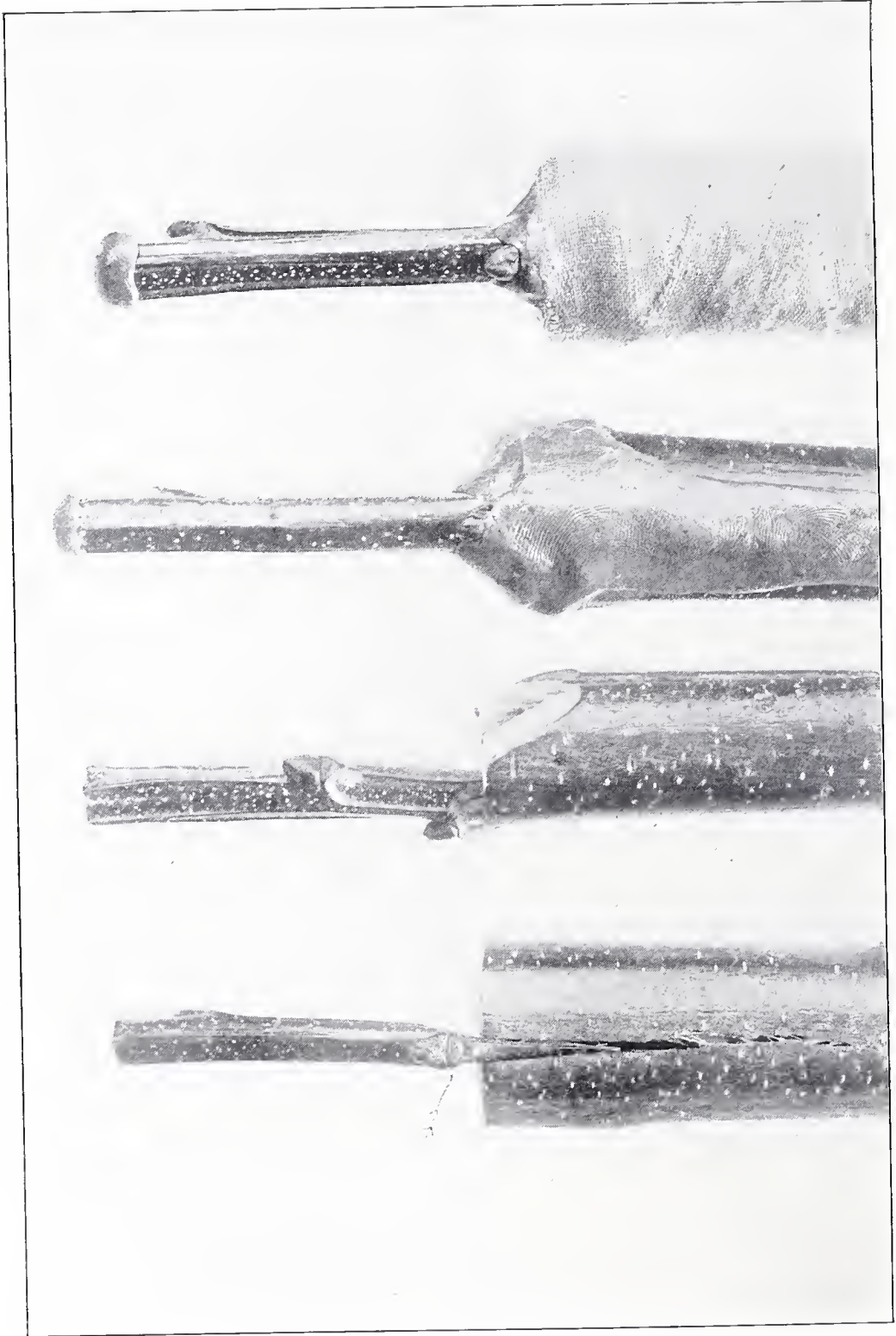


Fig. 15.—The “wedge” or “cleft” graft.

Fig. 16.—Wedge graft—Four years old.



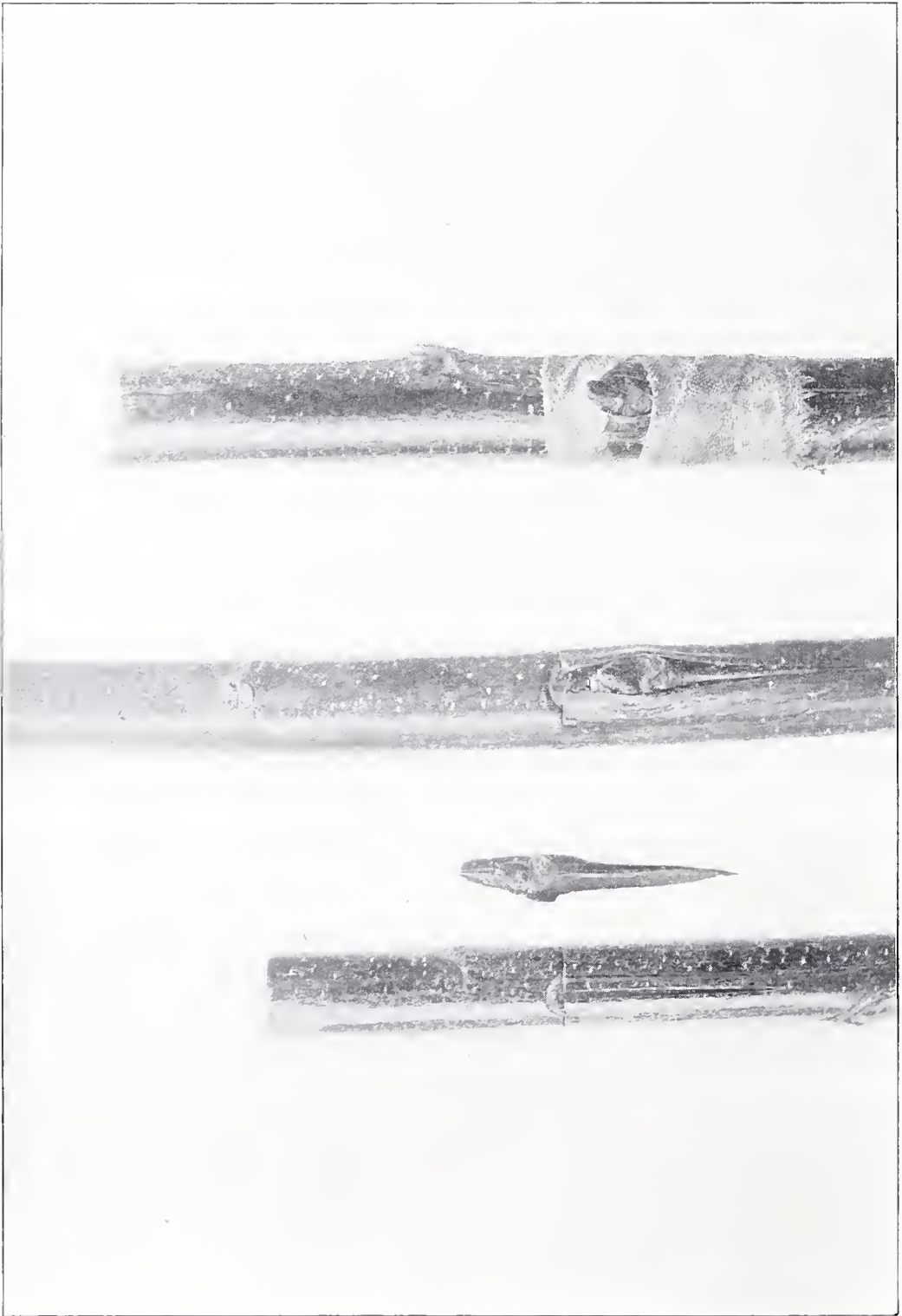


Fig. 17.—Budding.



Fig. 18.—Budding—Three years old.

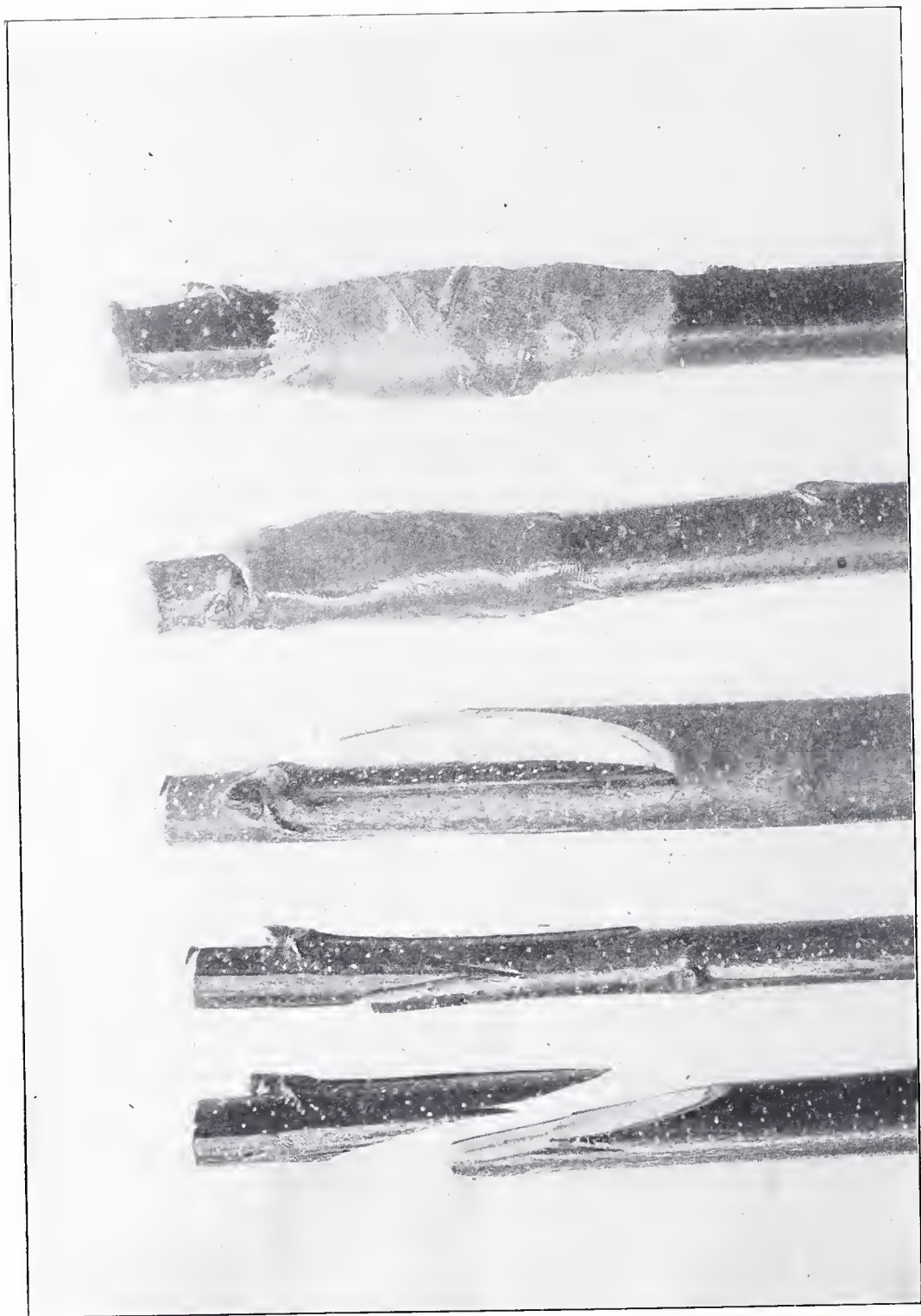
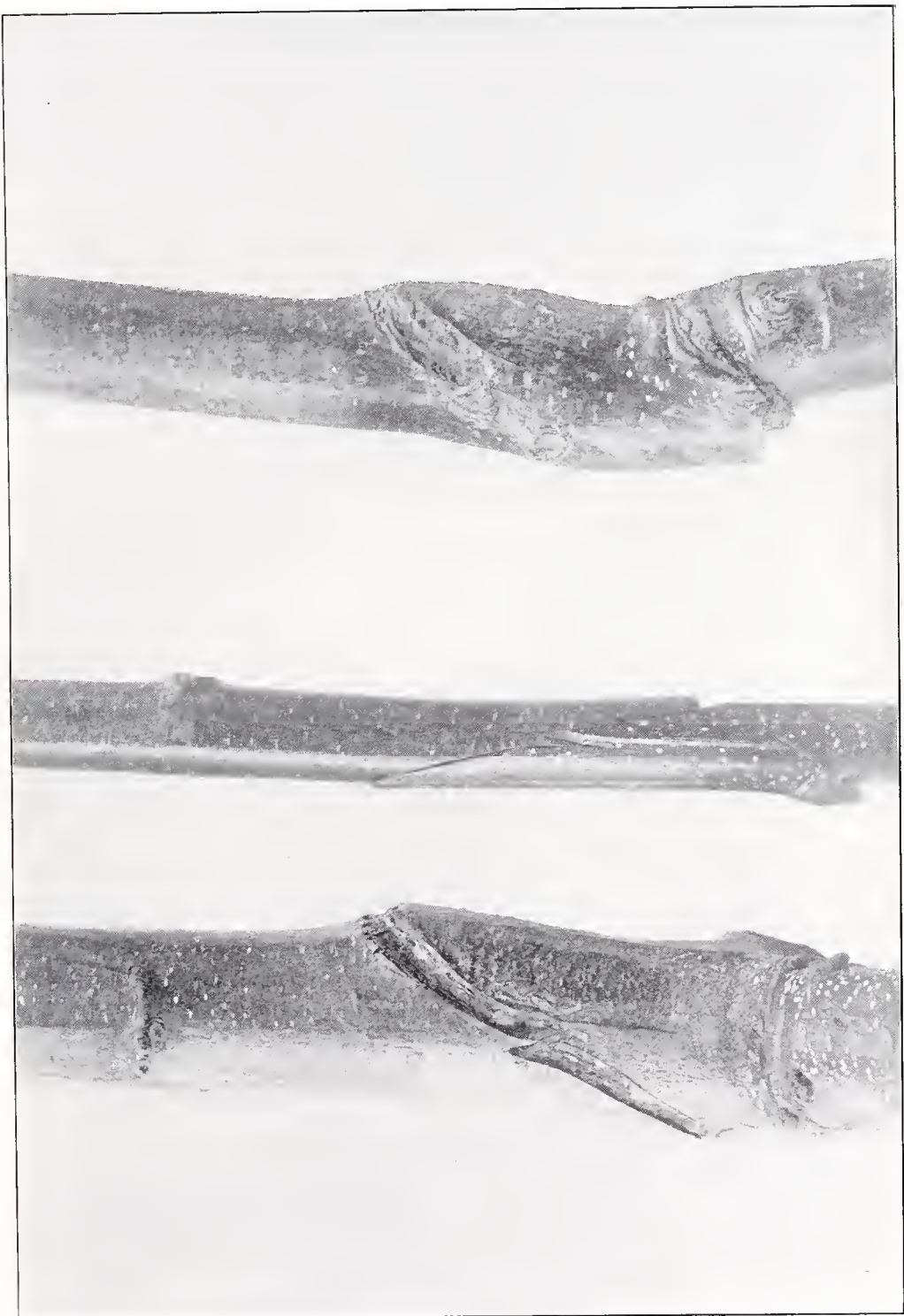


Fig. 19.—The “tongue” or “whip” graft.

Fig. 20.—The "whip" or "tongue" graft.



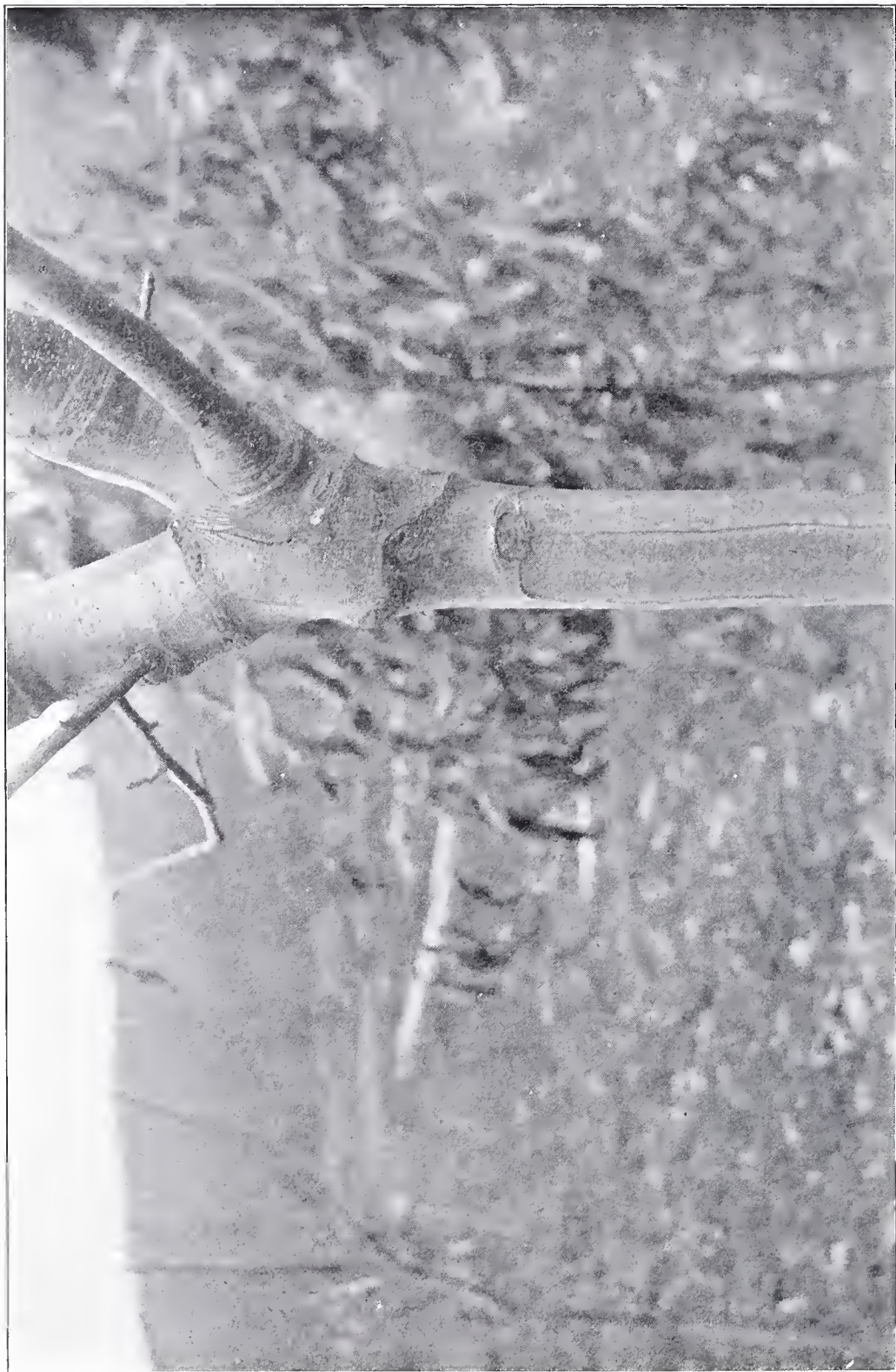


Fig. 21.—Tongue graft—three years old.



Fig. 22.—Grafting outfit; scisors, machine for winding waxed muslin on corn-cobs.

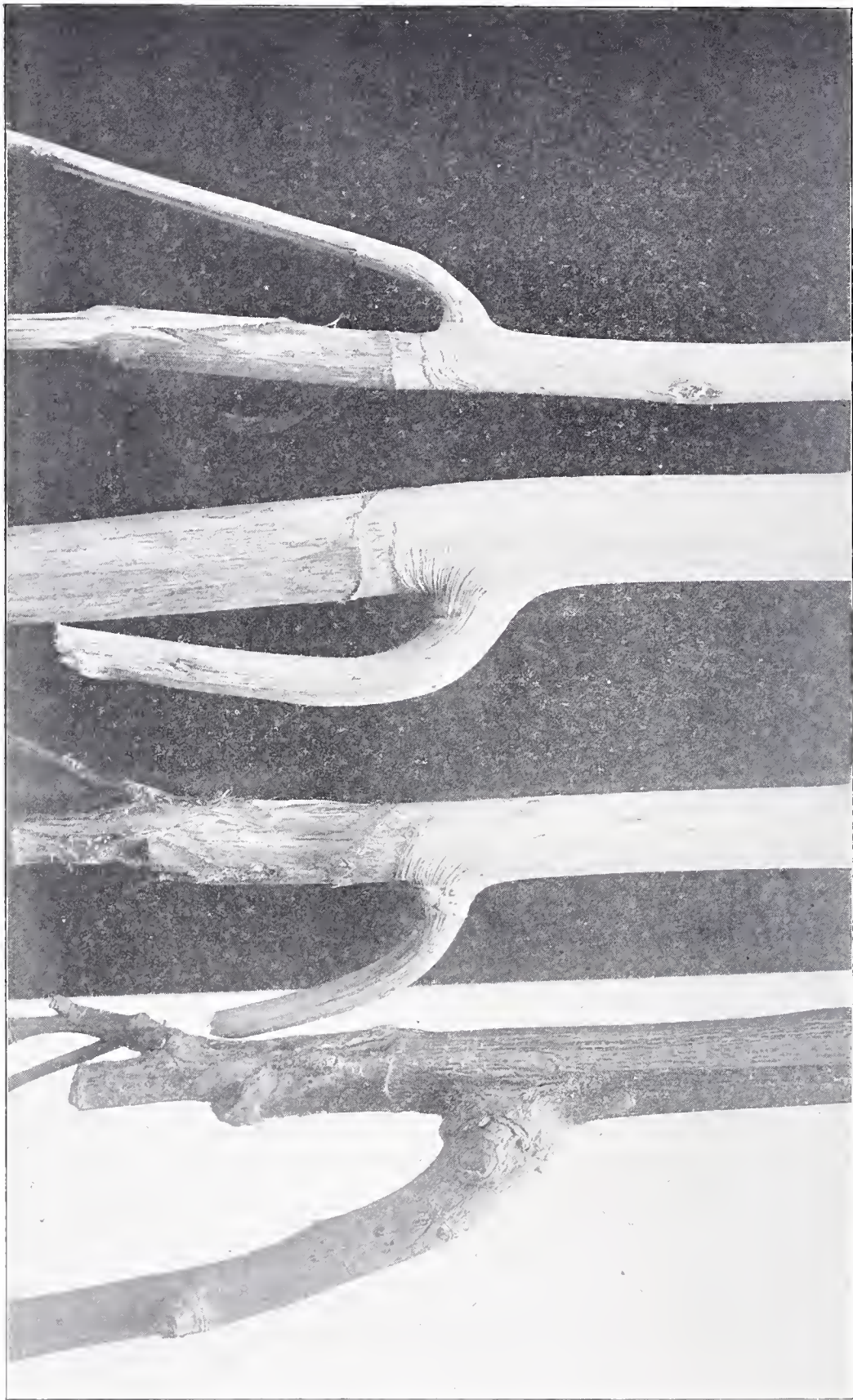


Fig. 23.—Buds left on the stocks below the grafts will get all the nourishment, and the grafts will die.

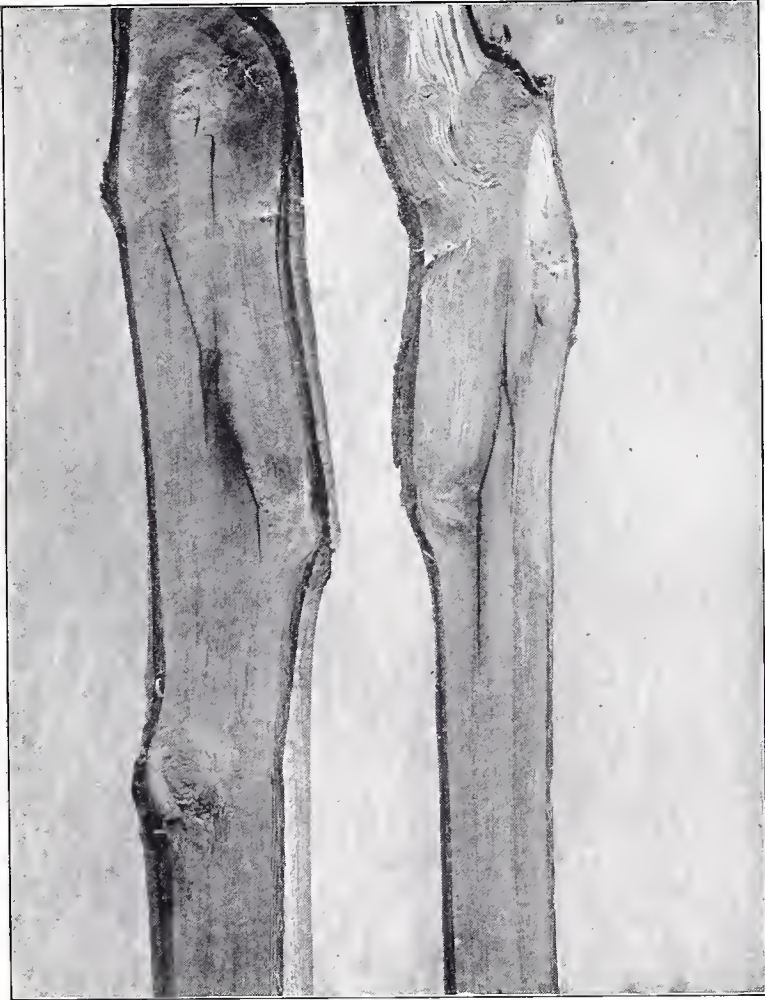


Fig. 24.—Perfect union, whip graft.



Fig. 25.—Defective whip graft.



Fig. 26.—Cleaning the grove. Asbestos covered screens protect the trees from the fire.



Fig. 27.—The grove in Winter. No danger from forest fires.



Fig. 28.—The trees in the grove are too thick. Improvement cuttings are being made continually.

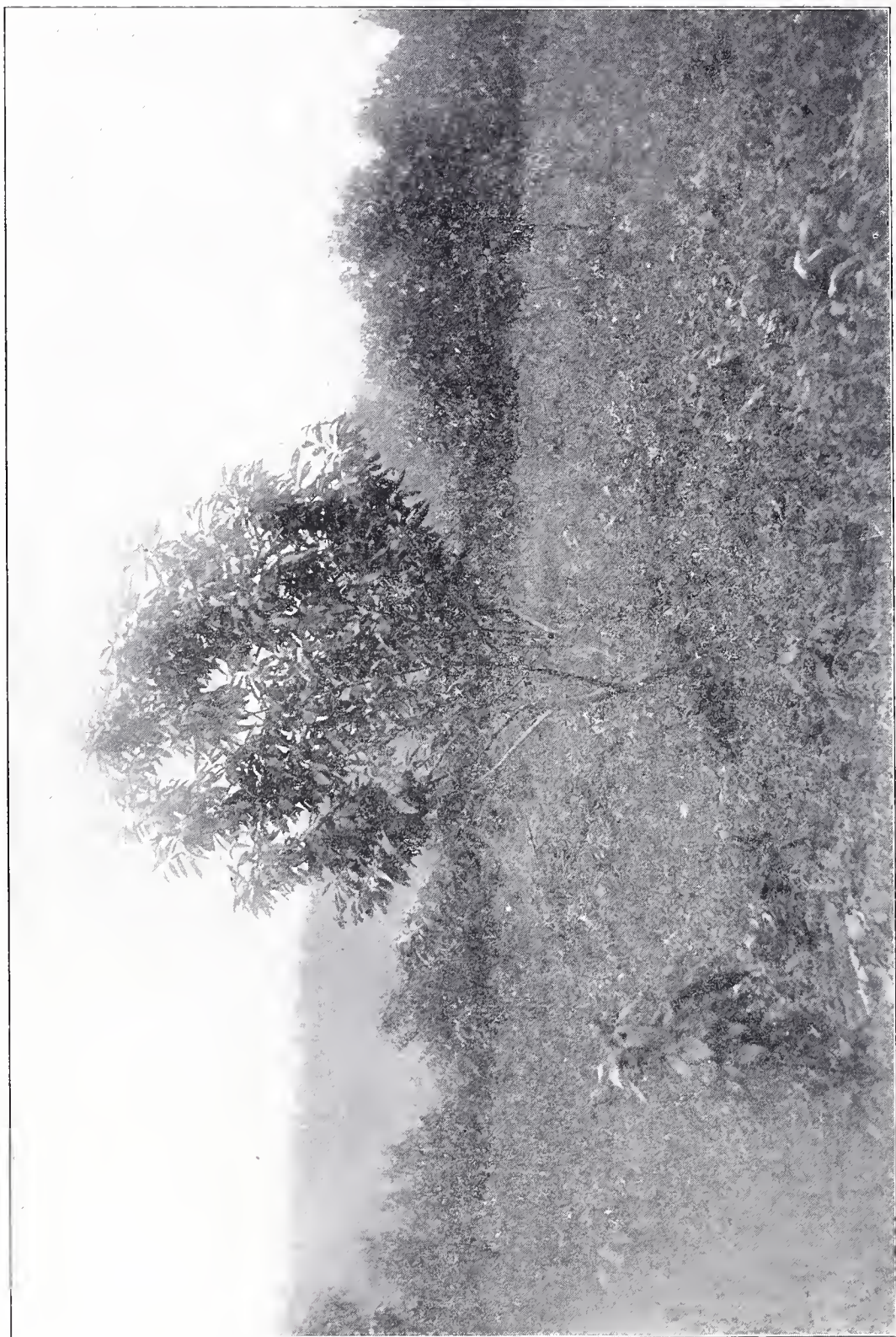


Fig. 29.—An ideal tree.



Fig. 30.—A normal yield.

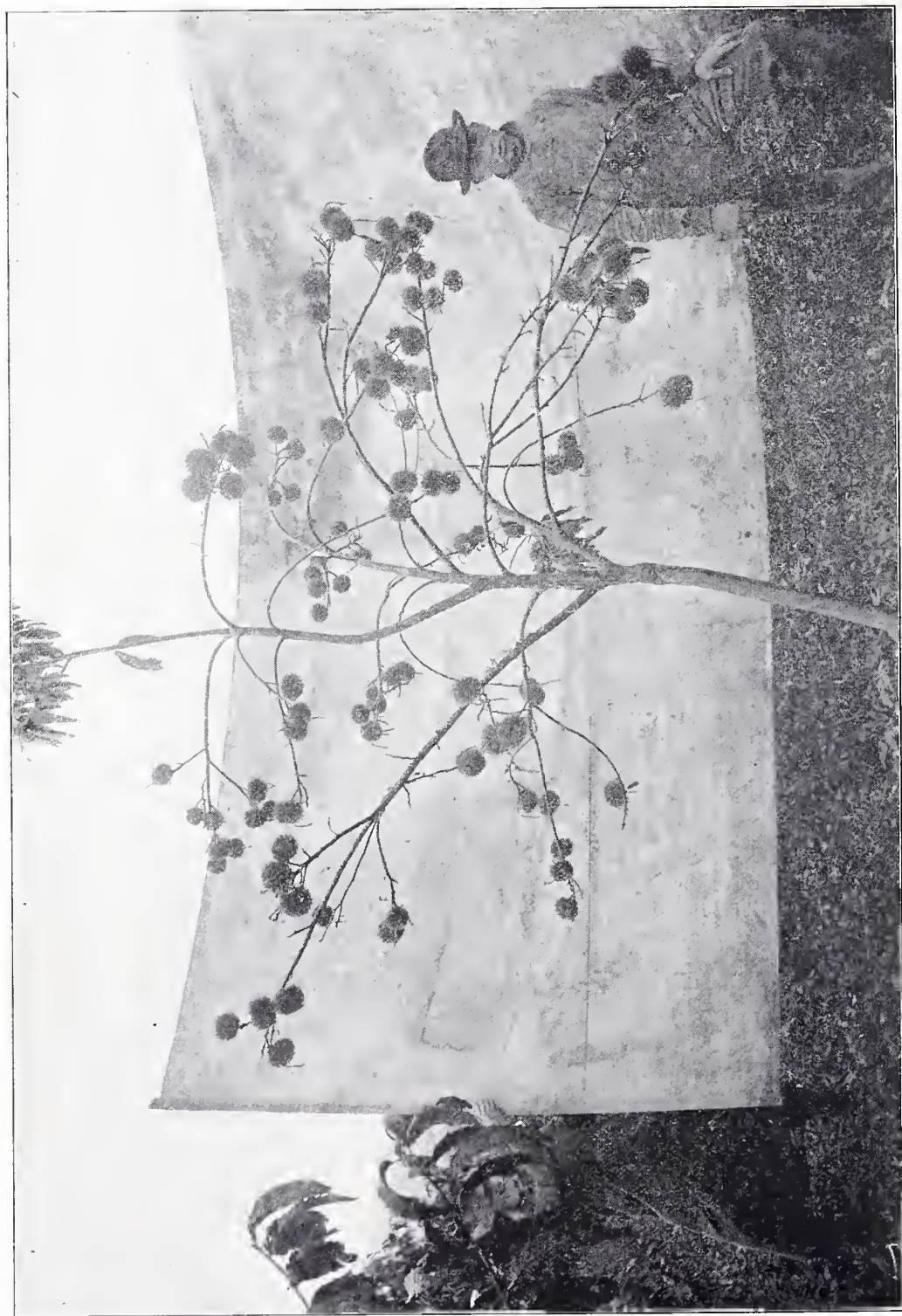


Fig. 31.—Three hundred young burs were picked from this tree; two hundred were left to mature.

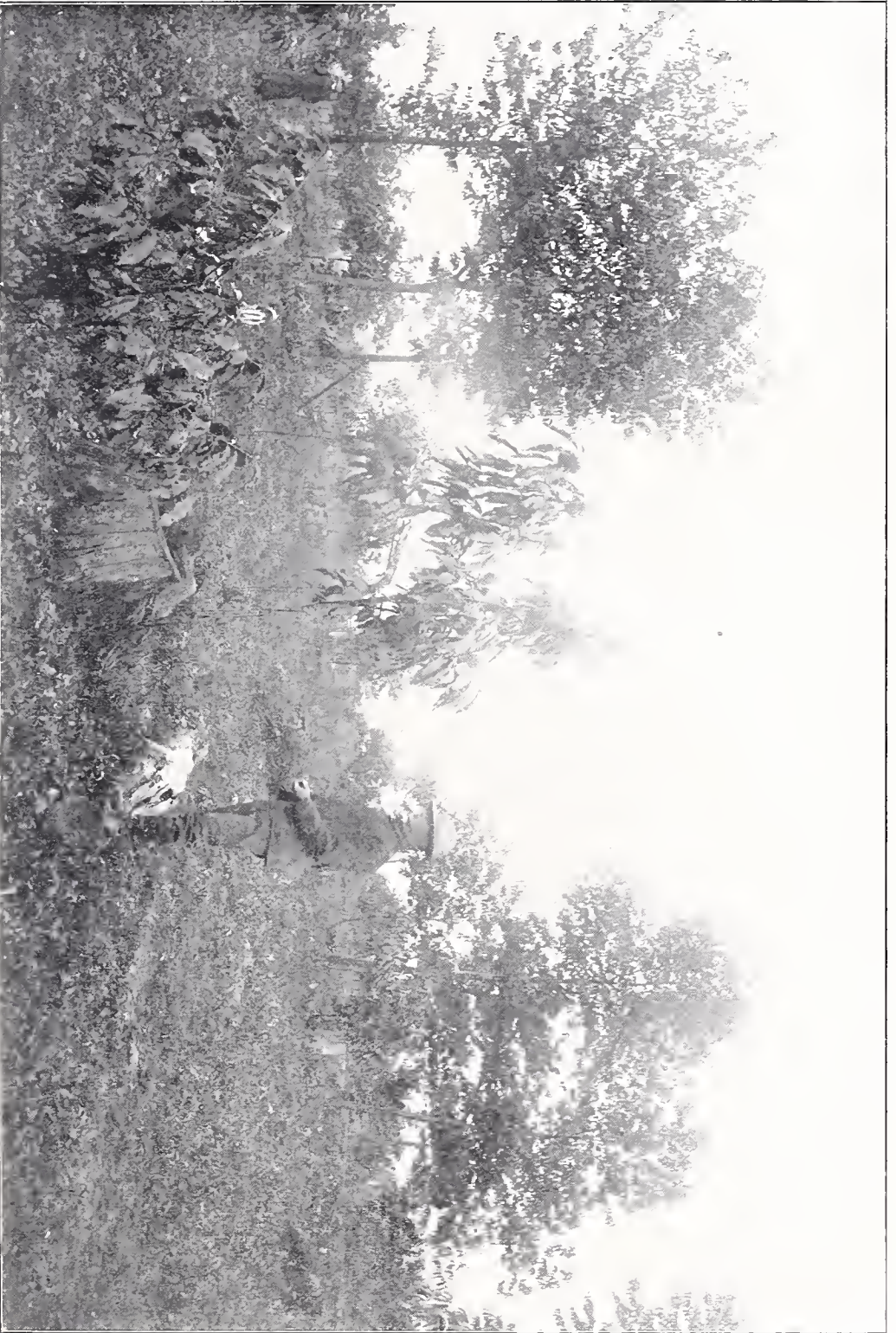


Fig. 32.—The grafting of large trees did not prove a success.

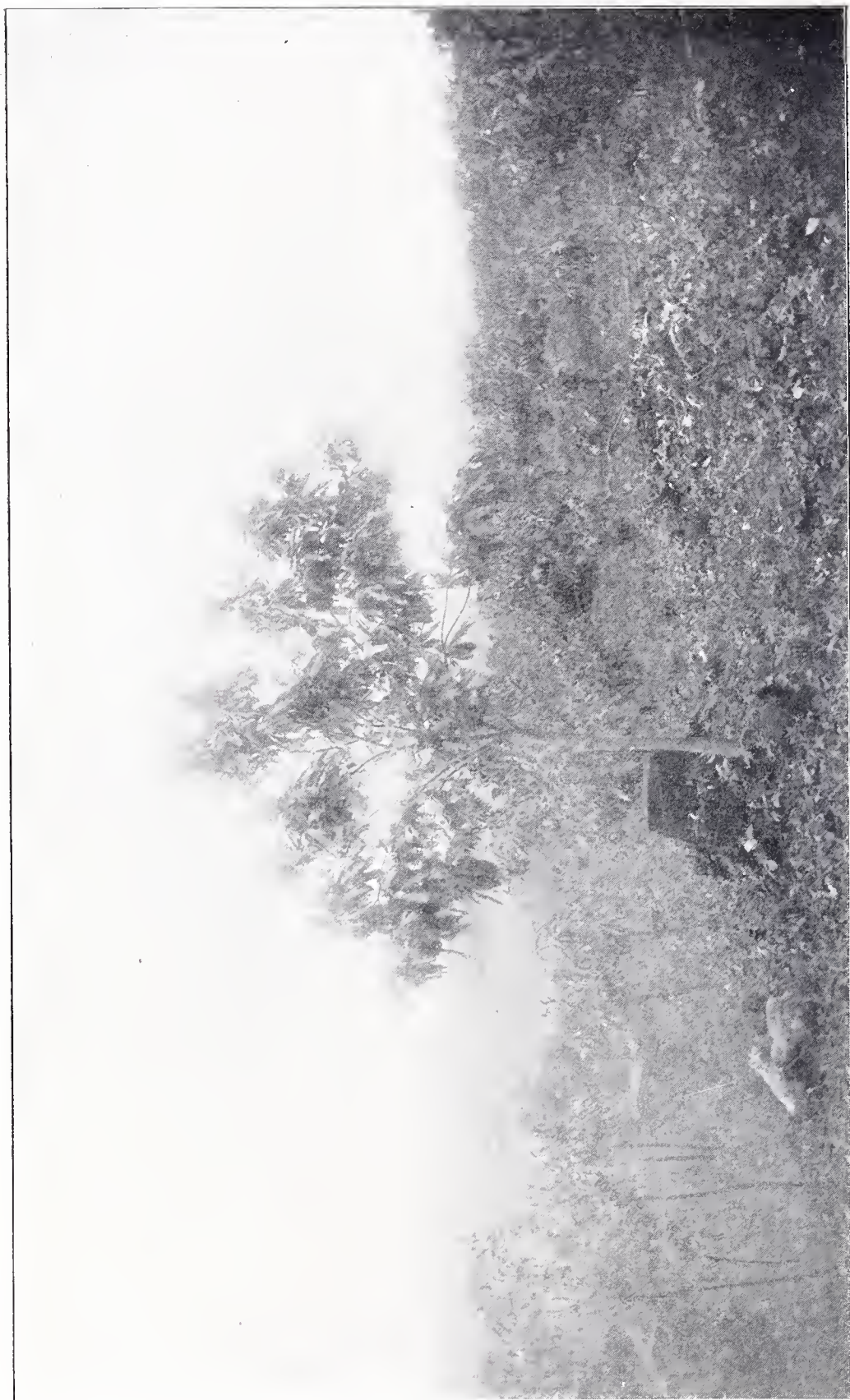


Fig. 33.—Chickens devour many insects.



Fig. 3/.—Paragon nuts sprouted, ready for planting. Mr. Sober cuts the sprouts off before planting the nuts.



Fig. 35.—Seedlings from Paragon Nuts. (See description of figure.)

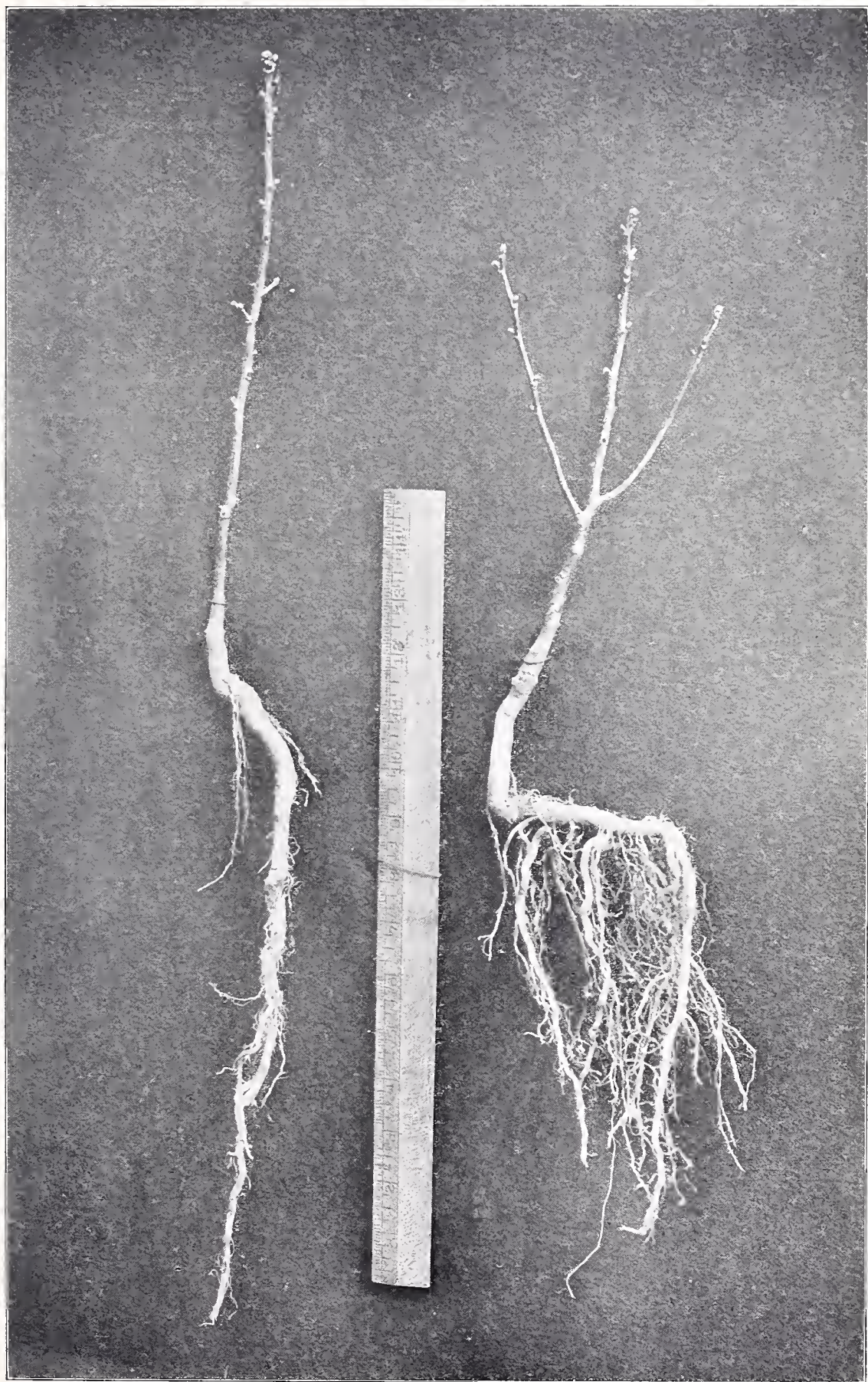


Fig. 36.—Seedlings from Paragon Nuts. (See description of figure.)



Fig. 37.—Seedlings from Paragon Nuts. Photograph taken during the first Summer.

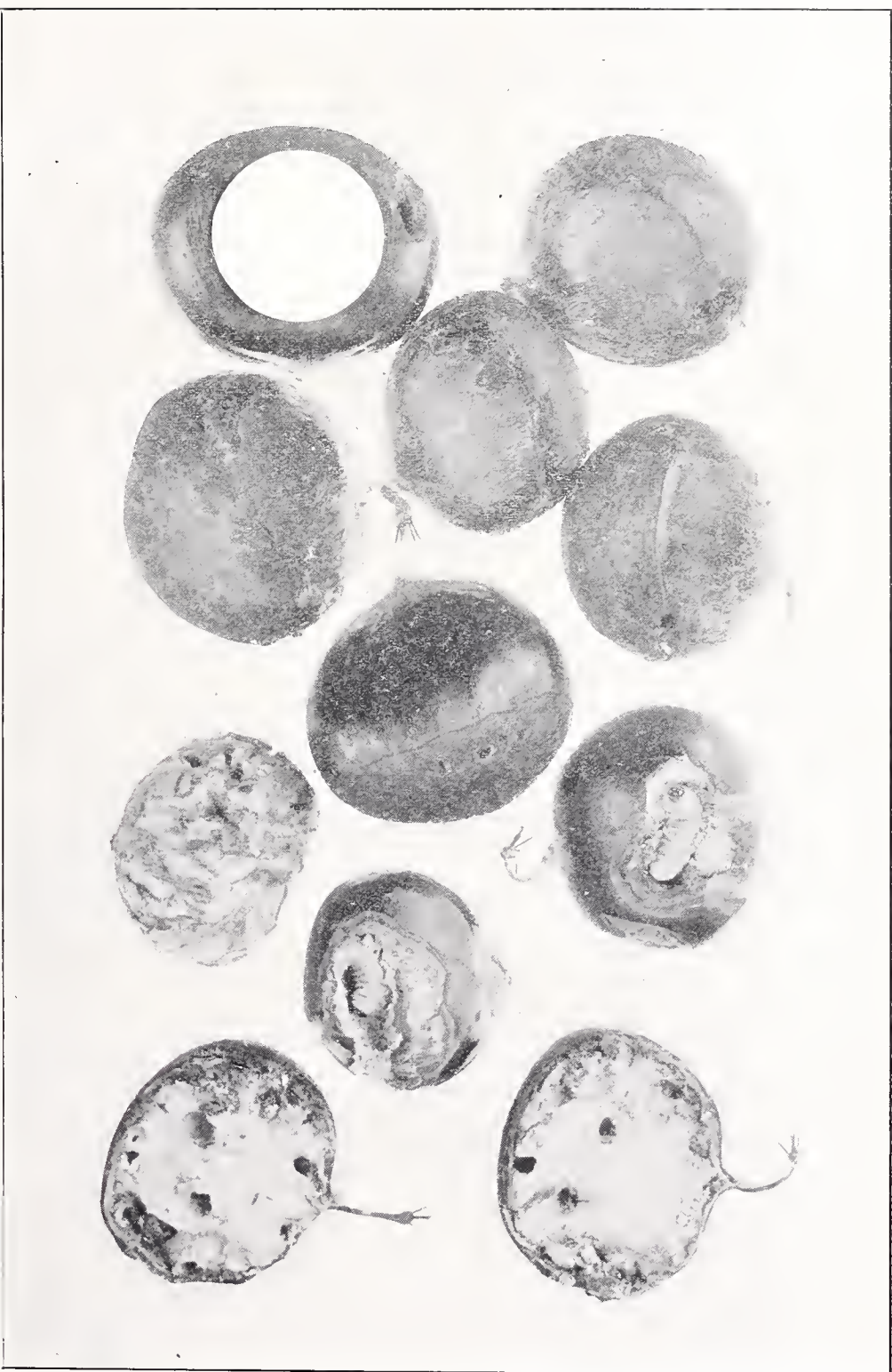


Fig. 38.—At the left, nuts destroyed by "bur-worms," on the right, destroyed by larvae of weevils.



Fig. 39.—Pupae of Chestnut Weevil, June, 1903.



Fig. 40.—Chestnut Weevil, (*Balaninus caryatrypes*). The female has the longer beak.



Fig. 41.—Chestnut Weevil— Natural size, August, 1903.

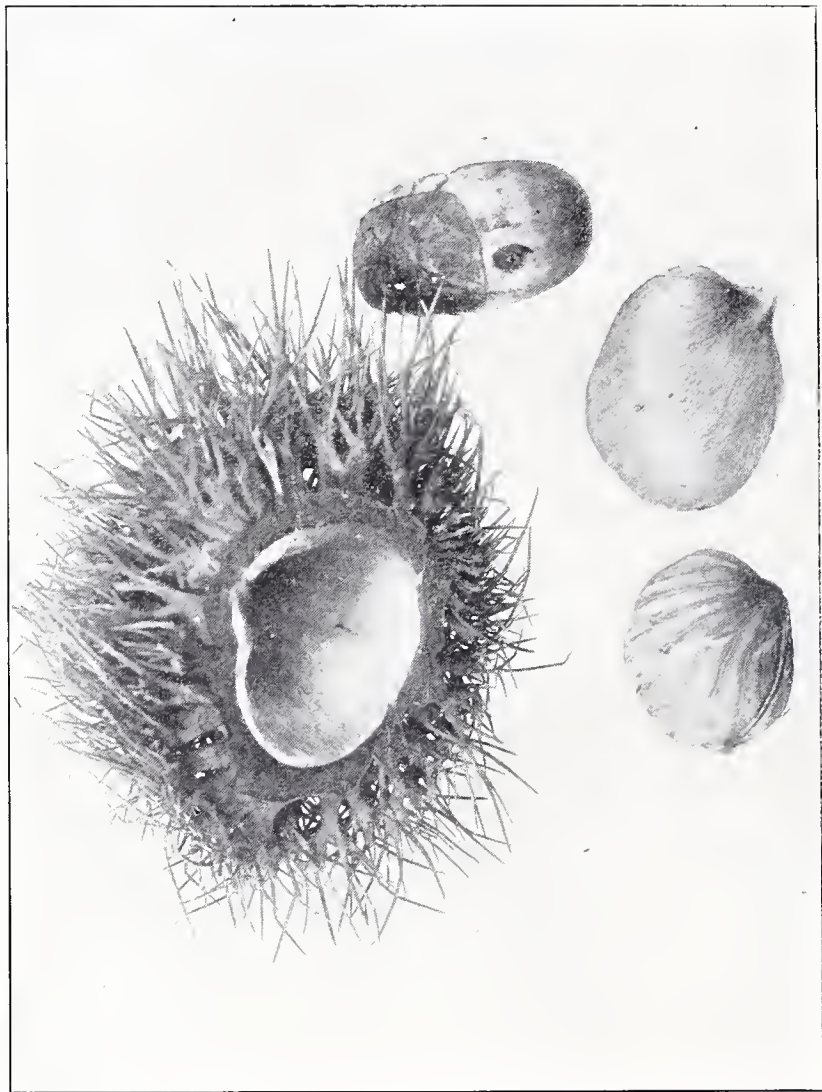


Fig. 42.—Snout of weevil penetrating bur. Below, the nut and seed-coat are shown, also pierced by snout.

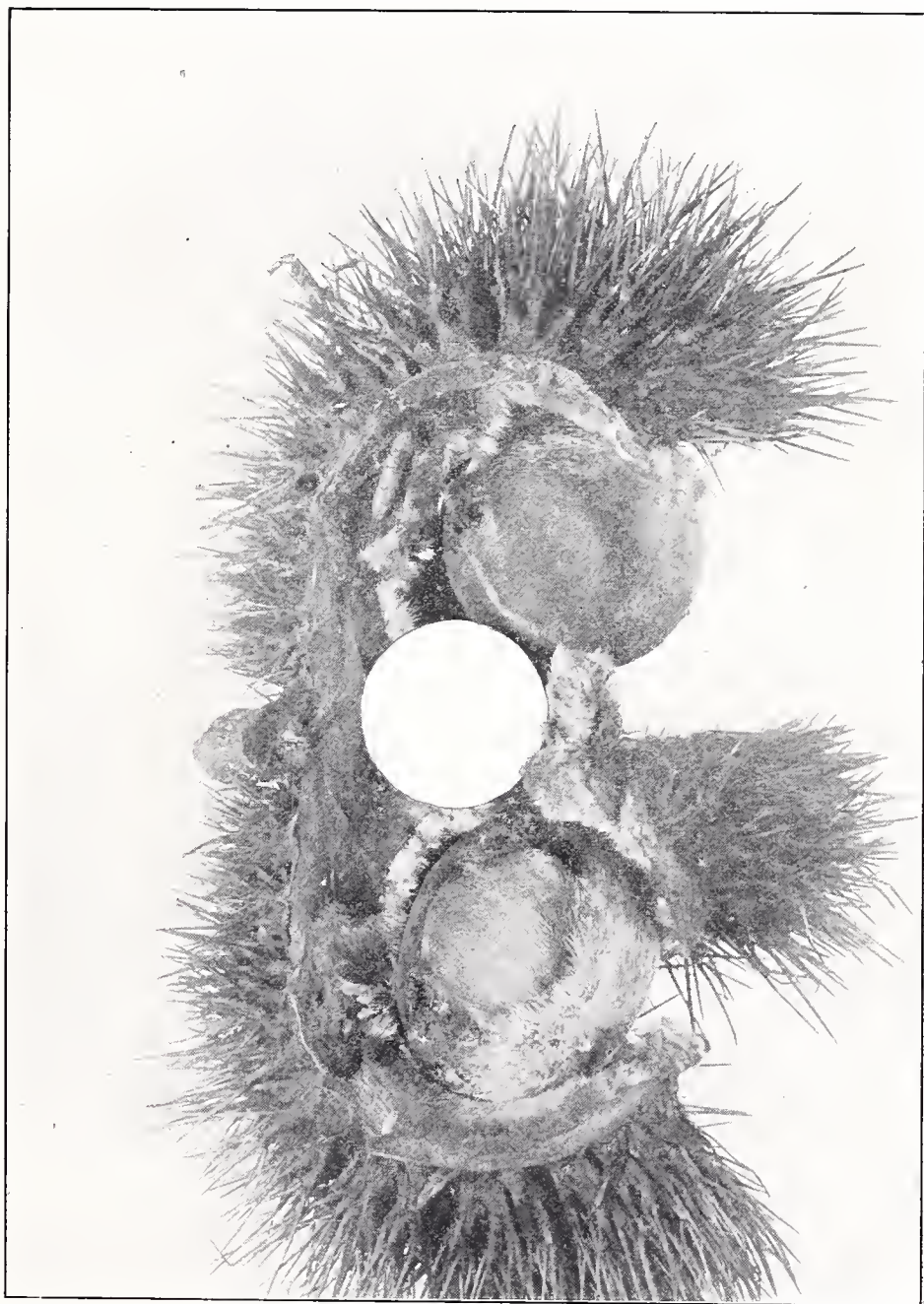


Fig. 13.—Bur-worm at work.

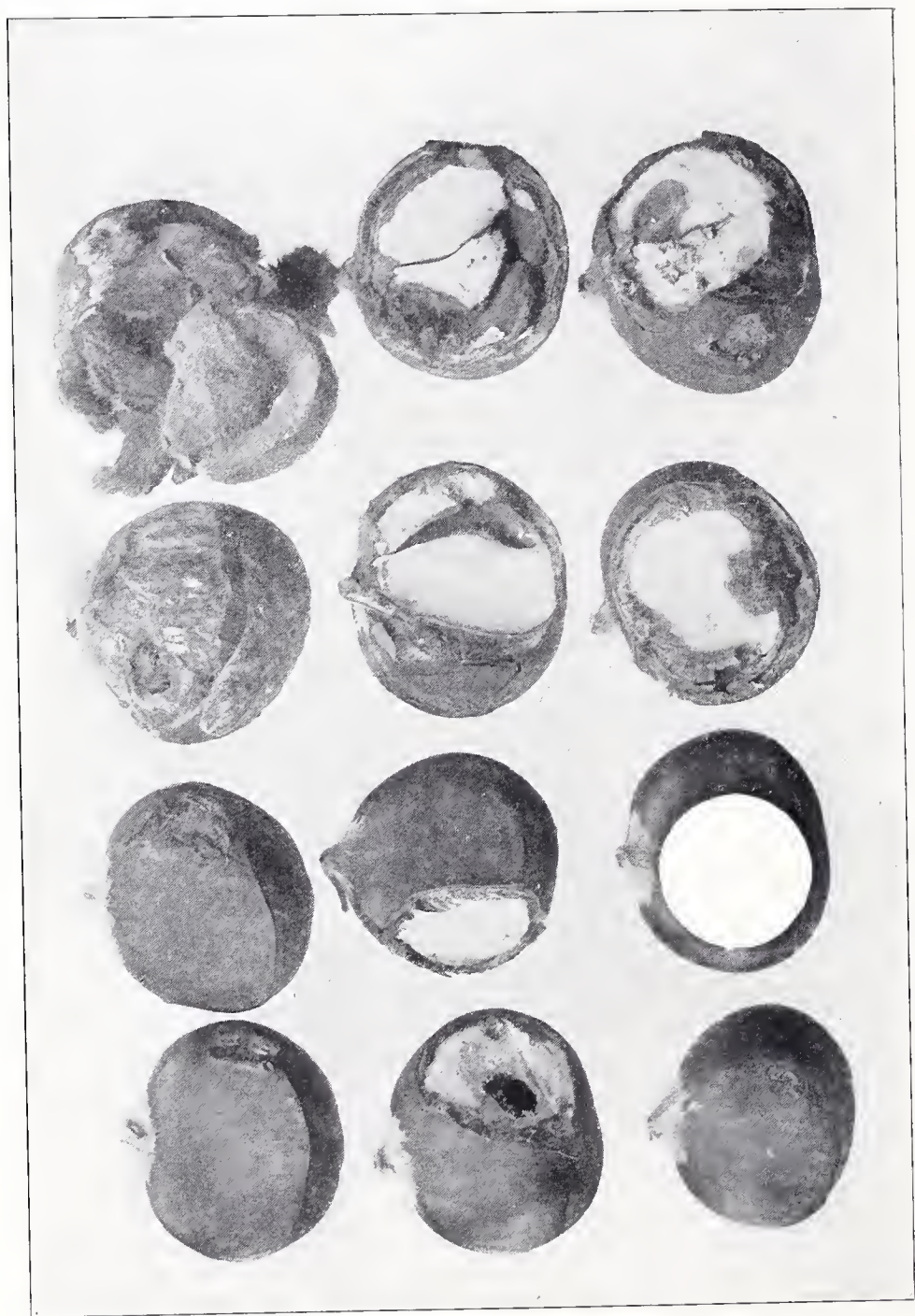


Fig. 44.—Nuts attacked by "bur-worm" will afterwards mould,



Fig. 45.—Defective graft—blown over by the wind.



Fig. 46.—Chestnut trees girdled by Meadow Mice.